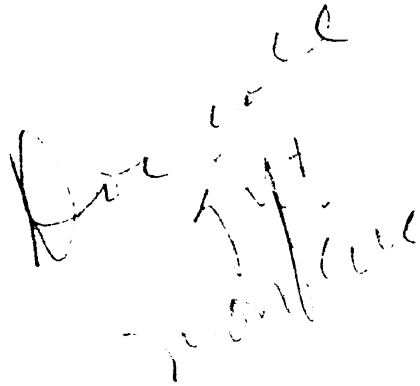
TM 10-225

WAR DEPARTMENT

TECHNICAL MANUAL

&

INSPECTION OF TEXTILES



TECHNICAL MANUAL

INSPECTION OF TEXTILES

CHANGES No. 1

WAR DEPARTMENT,
WASHINGTON 25, D. C., 12 September 1944.

TM 10-225, 20 August 1940, is changed as follows:

100. Ordering of cars from railroad.

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b. (Superseded.) Each set of Government bills of lading ordinarily furnished the contractor consists of the following eight sheets, unless printed instructions appear on the bills of lading themselves, in which case such instructions as to numbers of parts will prevail:

1. Government Bill of Lading (original) (Standard Form No. 1103, white paper).
2. Government Bill of Lading (shipping order) (Standard Form No. 1104, salmon colored paper).
3. Government Freight Waybill (original) (Standard Form No. 1105, white paper).
4. Government Freight Waybill (carrier's copy) (Standard Form No. 1106, white paper).
5. Government Bill of Lading (memorandum copy) (Standard Form No. 1103a, yellow paper). (When a memorandum copy is required by regulation for the Chief Transportation, the copy is to be marked, "Copy for Chief of Transportation, War Department.")
6. Government Bill of Lading (memorandum copy) (Standard Form No. 1103a, yellow paper).
7. Government Bill of Lading (memorandum copy) (property shipped) (Standard Form No. 1103a, yellow paper).
8. Government Bill of Lading (memorandum copy) (property received) (Standard Form No. 1103a, yellow paper).

See AR 55-150.

* * * * * * *

101. Completion of Government bills of lading. When a shipment is ready to be turned over to the railroad company, surrender the shipping order (Part 2) and two freight waybill copies (Parts 3 and 4) to the agent of the initial carrier indicated thereon, and have him date and sign the original and the memorandum bills of lading where indicated, returning them to the inspector. The agent will retain the shipping order and the two freight waybill copies. The inspector will observe distribution instructions when such

instructions appear on the bills of lading themselves. The inspector will mail the original bill of lading **(Part 1)** and also the memorandum copy, which is stamped "Property Received Copy," **(Part 8)** to the consignee, **in the same** envelope. Two memorandum copies **(Parts 5 and 7)** should be mailed to the contracting depot and one copy **(Part 6)** given to the contractor (**provided** a sufficient number of copies **is** received to allow one for the contractor). In case the * * * they are furnished. **See AR 55–150.**

102. Distribution of bills of lading after completion.

* * * * * * *

See AR 55–150.

[A. G. 300.7 (28 Mar 44).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION:

As prescribed in paragraph 9a, FM 21–6:
SvC (10); ASF Deps (2); QM Deps (2) except Philadelphia QM Dep (10).
For explanation of symbols, see FM 21–6.

U. S. GOVERNMENT PRINTING OFFICE: 1944

TECHNICAL MANUAL
No. 10–225

WAR DEPARTMENT,
WASHINGTON, *August, 20, 1940.*

INSPECTION OF TEXTILES

**Prepared under direction of
The Quartermaster General**

SECTION I

GENERAL

1. Object of inspection.—The object of the inspection of textiles, as for any other class of supplies, is—

a. To insure that the article or material procured conforms in all respects to the specification and approved samples.

b. To protect the Government against loss through acceptance of defective or inferior articles or materials and to protect the rights of unsuccessful bidders.

c. To keep the contractor on the alert so that he will take special care in manufacture to have all material and workmanship up to specification requirements; to cooperate with the contractor, particularly with respect to interpretation of specifications and contractual requirements, and with regard to technological aspects of production.

d. To keep the contracting depot advised as to the operating conditions and the status of operations at the plant.

2. Types of inspection.—*a.* The following types of inspection are used in the inspection of textiles:

(1) Inspection during course of manufacture.
(2) Inspection at point of acceptance.
(3) Laboratory inspection.

b. Inspection during course of manufacture.—Inspection during course of manufacture is resorted to when the nature of the material being purchased is such that it is difficult to determine full contract compliance from an examination of the finished product, or when manufacture involves inherent difficulties of a technological aspect, particularly in the case of supplies not ordinarily produced by the contractor. This type of inspection is accomplished by assigning one or more competent inspectors to the mill or mills involved.

c. Inspection at point of acceptance.—Inspection at point of acceptance may be made either at contractor's mill or at the receiving depot, depending upon the terms of the contract.

(1) Final inspection and acceptance at the point of manufacture requires the use of inspectors of the highest type, both in technical knowledge and in trustworthiness. Once an inspector has accepted supplies on behalf of the Government, the United States is bound by his actions, in the absence of gross negligence or fraud.

(2) Except in times of great emergency or where the exigencies of the situation are such as to require the shipment of fabrics direct to clothing manufacturers, textiles will usually be purchased on basis of final inspection and acceptance at the receiving depot, as this method assures maximum protection of the Government's interest.

d. Laboratory inspection.—Inspection during the course of manufacture and inspection at point of acceptance must always be supplemented by laboratory inspection. Such essential determinations as weight, strength, color fastness, shrinkage, and fiber content can be determined only in the laboratory.

3. Organization of textile industry.—The textile industry is composed of a number of divisions which have very little in common, except weaving. The principal divisions of the industry, and the

most important branches into which each is subdivided are shown in the following table:

Textile industry

Cotton	Wool and worsted	Silk	Rayon	Knit goods
Grower. Gin. Cotton broker. Spinning. Weaving. Finishing Selling agent.	Wool grower. Wool broker. Top maker. Spinning. Weaving. Finishing. Selling agent.	Silk grower. Importer. Throwing. Weaving. Finishing. Selling agent.	Chemical manufacturer. Weaving. Finishing. Selling agent.	Spinning. Knitting. Finishing. Selling agent.

SECTION II

PERSONNEL

4. General.—*a.* The efficiency of any inspection force depends upon the technical knowledge, good judgment, and integrity of the individuals of which it is composed. Textile inspectors must frequently perform their duties under a minimum of supervision and the protection of the Government's interest depends upon their action. Once an inspector accepts supplies tendered for delivery under a contract, the Government, in the absence of a showing of gross negligence or fraud, is bound by his actions.

b. The textile industry is so large and consists of so many branches that it is impossible to find an inspector who is competent to pass upon work performed in all branches. Normally, the cotton spinner knows little or nothing about weaving or finishing, and the weaver or finisher knows nothing about other work. The cotton man knows nothing about the manufacture of woolen or worsted goods; the rayon manufacturer is the chemical engineer, and the knitter is only interested in turning yarn, made by others, into a usable fabric.

c. The average mill hand's technical knowledge is usually limited to a very few operations, and he does not have broad enough knowledge to intelligently perform the duties of a senior textile inspector. However, such men may be used as junior inspectors, either working under the direct supervision of a senior inspector, or as examiners of finished material.

d. Mill foremen are usually competent to inspect work performed only in those departments in which they have had experience. As a rule, these men know little about the operation of more than one department of the mill.

e. Mill superintendents are usually competent to inspect work produced by the branch of the industry in which they have had experience, but they have little or no knowledge of work produced by other branches of the industry.

f. Graduates of textile schools usually are well qualified for use in textile testing laboratories. However, it will be found that they have specialized in one branch of the industry during their time at school, and can be used as inspectors only in that particular branch.

5. Type required.—The textile inspection force must be so organized as to be able to pass upon all classes of textiles. Therefore, it must have available textile specialists of all kinds. Textile inspectors required in a typical organization are as follows:

Wool grader.
Cotton classifier.
Inspector of cotton goods.
Inspector of woolen and worsted goods.
Inspector of knit goods.
Inspector of miscellaneous textiles.
Laboratory technicians.
Chemists.
Textile examiners (junior inspectors).

Where a number of inspectors are assigned to one activity, this inspection force is organized into an inspection section which functions under the supervision of the contracting officer of the depot. This inspection force is organized as follows:

Chief inspector.
Commodity inspectors (in such number as may be required).
Chemist (or inspector qualified as chemist).

6. How obtained.—*a.* The employment of textile inspectors and all other personnel required for textile inspections must be in accordance with existing laws and regulations. Normally, all employees are obtained through Civil Service.

b. In an emergency, good men with practical experience will be scarce. Most of the better men will be holding key positions in textile organizations and probably cannot be spared for duty as Government inspectors. However, through the cooperation of industry, some experienced men may be obtained, and these, supplemented

by students of the senior classes of the various textile schools should be sufficient.

7. Instruction.—*a.* The instruction of inspection personnel is a matter of the greatest importance, and one that, in an emergency, is often neglected. Textile inspectors must have had some technical training prior to being employed; otherwise, they will be of little or no value as time and facilities will probably never be available for more than a refresher course of instruction. Newly employed inspectors can be expected to know little or nothing of the administrative duties connected with their position. Therefore, a minimum length of time required for instruction, before assigning them to duty, is that amount necessary to familiarize them with administrative procedure.

b. The instruction of inspectors should include the study of manuals on general administrative procedure, and conferences on the duties to be performed. The Quartermaster General issues general instruction for inspectors with which they must become familiar. These are supplemented by special instructions issued by the depots from which the inspectors are to work. In addition, such technical instructions must be provided as circumstances will require and permit.

c. The following is a typical 2-weeks' training program for a woolen textile inspector. This program may be modified to cover other classes of textile inspectors.

Program

Date	Period	Subject
First day.	9 to 10 AM.	Enrollment.
	10 to 11 AM.	Address.
	11 to 12 AM.	Lecture—Necessity for inspection; procurement as related to inspection.
	Luncheon.	
	1 to 2:30 PM.	Examination on background.
	2:30 to 4 PM.	Color blindness tests.
Second day.	9 to 10 AM.	Lecture—Inspectional procedure.
	10 to 12 AM.	Wool grading.
	Luncheon.	
	1 to 2 PM.	Lecture—Test methods for wool textiles.
	2 to 4 PM.	Laboratory demonstration—Test of textiles.
Third day.	9 to 10 AM.	Form and minutia of specifications.
	10 to 12 AM.	Exercise on specifications.
	Luncheon.	
	1 to 2 PM.	Laboratory demonstration—Tests.
	2 to 4 PM.	Laboratory demonstration—Tests.

Program—Continued

Date	Period	Subject
Fourth day.	9 to 10 AM.	Wool grading.
	10 to 12 AM.	Do.
	Luncheon.	
	1 to 2 PM.	Cloth analysis.
	2 to 4 PM.	Do.
Fifth day.	9 to 10 AM.	Lecture—Importance of correct packing, marking, and labelling of shipments.
	10 to 11 AM.	Lecture and demonstration—Methods of packing and marking of shipments.
	11 to 12 AM.	Exercise—Packing and marking shipments.
	Luncheon.	
	1 to 2 PM.	Lecture—Organization and methods of material inspection in depots.
	2 to 4 PM.	Demonstration—Conduct of depot material inspection.
Sixth day.	9 to 10 AM.	Dyeing and finishing.
	10 to 12 AM.	Wool grading.
	Luncheon.	
	1 to 2 PM.	Lecture—Contractors' inspection.
	2 to 4 PM.	Lecture and demonstration—Chemical analysis of cloth.
Seventh day.		Sunday—No classes.
Eighth day.	9 to 10 AM.	Lecture—Bills of lading—How and when used.
	10 to 12 AM.	Practice—Accomplishing bills of lading.
	Luncheon.	
	1 to 2 PM.	Color matching and shading.
	2 to 4 PM.	Shading practice.
Ninth day	9 to 10 AM.	Lecture—Receiving reports—how and when used.
	10 to 12 AM.	Practice—Preparation of receiving reports under varying conditions.
	Luncheon.	
	1 to 2 PM.	Lecture—Handling of samples and conduct of correspondence.
	2 to 3 PM.	Finishing of fabrics.
	3 to 4 PM.	Merino yarn manufacture.
Tenth day.	9 to 10 AM.	Lecture—Accounting for government materials furnished to contractors.
	10 to 12 AM.	Illustrative problem—Accounting for government materials furnished to contractors.
	Luncheon.	
	1 to 2 PM.	Weaves used in government fabrics.
	2 to 4 PM.	Perching cloth for defects.
Eleventh day.	9 to 10 AM.	Wool grading.
	10 to 12 AM.	Do.
	Luncheon.	
	1 to 2 PM.	Lecture—Expediting mill production.
	2 to 4 PM.	Laboratory demonstration—Test methods.

Program—Continued

Date	Period	Subject
Twelfth day.	9 to 10 AM.	Lecture—Packing and baling of supplies.
	10 to 11 AM.	Demonstration—Packing and baling of supplies.
	11 to 12 AM.	Lecture—Travel regulations and vouchers—how prepared.
	Luncheon.	
	1 to 2:30 PM.	Blanket manufacture.
	2:30 to 4 PM.	Do.
Thirteenth day.	9 to 10 AM	Lecture—Inspector's manual and its use.
	10 to 11 AM.	Examination—Wool grading.
	11 to 12 AM.	Examination—Dyeing and finishing.
	Luncheon.	
	1 to 2 PM.	Examination—Fabric analysis.
	2 to 3 PM.	Examination—Forms and procedure of inspection.
	3 to 4 PM.	Address.
Fourteenth day.		Departure of student personnel for home stations.

NOTES

1. Study hours suggested for students—8 to 10 PM.
2. References for study will be announced the day prior to the one on which class is held.
3. General references:
   Inspectors' texts.
   The 5-series of Army Regulations.
   Applicable War Department specifications.
   Q. M. Circulars 1-1 to 1-15.

SECTION III

RAW MATERIALS AND YARNS

8. Properties required of textile fiber.—In working with material that is to be used as a textile, it is desirable that something be known of the fundamental properties a fiber must have to be considered for textile purposes. These are—

a. Tensile strength.—The most important quality that a fiber must have is strength. Without this quality it cannot be spun into a yarn.

b. Length of fiber.—A fiber is made up (except in some cases) of

a series of segments of various lengths. These lengths must be sufficient to be worked mechanically in obtaining the necessary strength. The shortest lengths usable for spinning of yarns is about 0.2 inches.

c. Surface capable of friction (cohesiveness).—By this is meant the property of the individual fibers to cohere or cling to one another when spun. This is illustrated by the scales, serrations, and the crimp in wool, convolutions or twist in cotton, and roughness of the surface in linen.

d. Flexibility and elasticity.—A fiber must be flexible enough to be wrapped around another fiber in the spinning. The stiffer a fiber, the less is its value for making a pliable fabric. Wool, being very pliable, makes a large number of soft fabrics, while horsehair, which is stiff, makes a stiff fabric.

e. Fineness of staple.—All fibers used for textile purposes have small diameters. Generally the smaller the diameter, the finer the diameter of the yarn that can be produced. Silk, having a small diameter of fiber, makes a fine fabric, while bast fibers like jute, hemp, and sisal, having large diameters, can be used only in coarse fabrics.

f. Uniformity of staple.—Evenness in the length and diameter of the individual fibers is a valuable property. Cotton and wool in their natural state vary considerably in their length. The quality of the yarn produced is improved in strength and evenness if the shorter and longer fibers are separated. This may be accomplished by a process known as "combing."

g. Permeability.—If the fiber does not absorb liquids and allows them to permeate the fiber it cannot be dyed, bleached, or modified from its natural condition.

h. Resistance to distintegration and decay.—The fiber must have enough permanence to withstand the conditions of reasonable wear.

i. Abundance.—The fiber must be readily available, and at a cheap price.

j. Luster.—Variation in the luster of the various fibers allows many beautiful effects in weaving.

9. Classification of fibers.—Textile fibers are made from a wide range of natural materials and, through chemistry, from many synthetic materials. In spite of the new fibers discovered each year, a fiber can be placed in one of the following four classes:

a. Vegetable.—Cotton, linen, jute, ramie, etc.

b. Animal.—Silk, wool, mohair, camel's hair, cashmere, vicuna, alpaca, llama, and rabbit.

c. Mineral.—Asbestos, glass, and glass and mineral wools.

d. Synthetic.—Rayon, vinyl polymers, polyamide polymers, casein, miscellaneous (protein, etc.), and metallic.

10. Vegetable fibers.—*a. Cotton.*—The vegetable fibers are made up of cells, and in most cases these cells are very small. Cotton is the hairy covering or lint on the seed of a plant. Cotton is rather remarkable in this connection, as it consists of a single elongated cell. All other vegetable fibers are multicellular and are obtained from the tissue, either leaf or stem, of plants. The growing and immature cotton fiber is a fairly long, straight, hollow tube of circular cross section. When it is fully grown, its surface begins to harden and dry and its cross section is changed to a collapsed, twisted tube. When cotton is ready for harvesting, the beard hairs (cotton) hang perfectly free in the air. The cotton is picked as soon as possible after ripening, and, because the seed is present, is known as "seed cotton." This "seed cotton" is contaminated with seed, dirt, burrs, parts of leaves, etc. These are removed in one or more steps in the processing known as ginning. The cotton fiber is a soft, fluffy lint varying in color from a light cream to a blue white. Egyptian and some South American cottons have a brownish color. The bulk of the crop ranges from ¾ to 1½ inches in length.

b. Linen.—Linen is the fiber obtained from the bast tissue of the flax plant. It is the most important of the bast fibers used for textiles. The plant has two industrial uses and is grown for either but not simultaneously. The seed is the source of linseed oil and the stalks give the linen fiber. The best linen is obtained from countries with a temperate climate. The plant is cut just before the seeds are ripe. The cut plant is drawn through a series of upright forks to free it of leaves and seed. This is known as rippling, which is followed by the process of retting. Retting is the decomposition of the woody tissue surrounding the fibers by fermentation or chemicals. The chemical process has not been successful and all fermentation is done by either pool retting, stream retting, or dew retting. The flax fiber varies in length from 12 to 36 inches. One ton of green straw will yield about 100 pounds of fiber.

c. Hemp and jute.—Hemp and jute are bast fibers obtained from different species of plants. The fibers of the plant are obtained by retting in a similar manner as in linen. The best grades of hemp are equal in strength, luster, and color to linen, except for evenness of staple. Jute is very coarse fiber, similar in structure to linen and hemp, except for the lumen. The best way to identify each is by microscopic means.

11. Animal fibers.—*a. Wool, mohair, camel's hair, cashmere, vicuna, alpaca, llama, rabbit.*—(1) Animal fibers constitute the protective covering of mammalian animals. The fibers are cylindrical in form and covered with a series of epithelial scales, which always point toward the tip. There are many varieties of true wool produced from different types of sheep. They differ in length and diameter of fiber, size and number of epithelial scales, felting power, natural curl, softness, luster, and color. According to their characteristics, they are suitable for different purposes. Wool is obtained either by shearing live sheep, in which case it is known as "fleece" wool, or is pulled from the hides of slaughtered sheep, and is then known as "pulled" wool. "Fleece" wool is of two kinds. The first time the sheep is shorn, the product is "hog" wool. "Hog" wool is finer in texture than subsequent shearings and has the pointed upper ends of the original fiber. The "pulled" wool is somewhat harsh, due to the action of the alkali on the wool substance. The epithelial scales are also frequently damaged. "Fleece" wool contains many impurities which may amount to as much as 65 percent or more of its weight, and consists of wool grease (lanolin), sand, burrs, and fecal matter. The usual color of clean wool is white or creamy white, although a large number of sheep grow gray, brown, or black wool. The grading of wool is discussed in paragraph 23*b*.

(2) In addition to the wool from sheep, the hairs from other animals are used in textiles: camel's hair, from the camel; mohair, from the Angora goat; cashmere, from the Cashmere goat; and wool from the Tibet goat and from the llama, alpaca, and vicuna of South America. These fibers are used to give special qualities to cloth.

(3) Reworked wools are those fibers which are reclaimed from some woolen materials. Noils are the short fibers that are removed from wool in the combing process in making worsted yarn. They are a true wool fiber, averaging about one-half inch in length. Another reworked wool is shoddy, which is reclaimed by tearing up, shredding, and carding the fibers from clean woolen rags and yarns that have not been felted or made into garments. The process tends to break the fibers and make them shorter and weaker than the original wool. A good shoddy made from a high grade woolen rag may be of better quality than a lower grade fleece wool. If reworked wool is obtained from felted, woolen materials, it is known as mungo. These fibers are very short and harsh. Some fabrics and garments are made not from one fiber alone but from the union of two or more fibers, as cotton and wool. When these union fabrics are shredded and treated by various acids or acid-producing chem-

icals, the cotton is separated from the wool. Wool obtained in this manner is known as extract wool. "Flocks" are short fibers (about one-sixteenth of an inch) that are removed from the surface of woolen cloth during the shearing operation. Flocks are not used in making yarn, but are used to increase the weight of cheap fabrics by felting the short fibers into the surface of the new cloth during the fulling or felting process.

(4) The demands for cheap grades of wearing apparel and other woolen commodities require the use of reworked wools. This economic factor influences the demand and production of virgin wool. In effect, it causes stocks of wool fiber in the various forms in which they exist to be used over and over again. This should be considered in the event of an emergency, and reclamation made of all woolen garments. The various reworked wools are seldom used alone, but are blended with fleece wools, pulled wools, or cotton. The fleece and pulled wools are used to improve the quality, strength, and spinning of the blend.

b. Silk.—(1) Silk, as a textile fiber, possesses to a very high degree the properties of strength, elasticity, durability, and receptivity to dye. It is the double filament produced by species of caterpillar in spinning their covering or cocoon. The filament is obtained by unwinding or reeling from the cocoon the filaments from five cocoons (ten filaments) and combining them to form a commercial thread. In this form, with the waxy covering (sericin) on the filaments, it is imported from Japan and China as raw silk.

(2) *Organzine* is generally made from the best quality silk. It is used chiefly for warp, usually 2 ply with 14 to 16 turns of twist in the ply to gain strength.

(3) *Tram* is generally made from the poorer quality silk. It is most often used for filling yarn in 2 or more ply, usually with but 2½ to 3 turns of twist to keep it soft.

12. Mineral fibers.—*a. Asbestos.*—The minerals used directly in making textiles are limited. The only mineral used for that purpose is a fibrous form of a silicate of magnesium and calcium containing various amounts of iron, aluminum, and other mineral impurities. It is obtained from a variety of rocks, known as amphiboles or serpentines. This material, after crushing and shredding, is used to make fireproof products, such as curtains, auto-brake linings, and fire-fighting clothing.

b. Glass, glass wool, and mineral wool.—(1) By drawing molten glass through an orifice of about 0.0002-inch diameter a continuous filament of glass is produced which is sufficiently flexible to be woven

into fabrics. By varying the composition of the glass, the chemical resistance of the material can be varied within limits to meet chemical requirements. "Fiberglas" is the trade name of a successful glass fiber product which is characteristically fireproof, mildewproof, chemical-resistant, and is not water-absorbent. It finds application for electrical insulation as glass tape.

(2) By blowing the glass from the furnace, fibers of from 8 to 15 inches in length are obtained, or by blowing steam through the glass, or through molten slag from blast furnaces, a fibrous mass of glass or mineral wool is formed. These "wools" are not used for textile purposes but do find wide application in thermal insulation and air filter applications.

13. Synthetic fibers.—*a. General.*—(1) Although as early as 1664 suggestion was made for the making of "artificial silk", and again in 1754 observation was offered as to a possible method, it was not until 1884 that Count Hilaire de Chardonnet was granted the first patent for the production of a synthetic fiber. However, within a half of a century the industry had risen to a gigantic size, which in 1939 produced approximately 333 million pounds of rayon.

(2) *Raw materials.*—The raw materials used in the manufacture of synthetic fibers vary with the type of fiber produced. The rayons are basically cellulose; Vinyon is produced from vinyl polymers of high molecular weight; Nylon and its variations are produced from polyamide polymers; and the other types generally indicate by their names the basic materials.

(3) *Manufacture.*—In general, the manufacture of synthetic fiber involves three steps:

(*a*) Solution of basic materials (reduction to fluid condition).

(*b*) Spinning of viscous material (extrusion through small holes of spinnerette).

(*c*) Coagulation or hardening of filament (chemical, evaporative, or cooling).

Necessarily, there are various preliminary processes by which the raw materials are purified, and other subsequent ones by which the filaments are prepared for sale. The coagulation or hardening of the filament may be by "wet" or "dry" process, depending on the method of manufacture. The wet process consists of the chemical coagulation (or precipitation) of the viscous material as a filament as it is extruded from the spinnerette. Dry spinning involves the evaporation of the solvent from the viscous filament as it is extruded from the spinnerette. Another important variation in manufacturing procedure involves the stretch spinning process for the production of

higher strength filaments of smaller diameter. The filaments are stretched out by being drawn away faster than they are extruded while they are yet plastic, or by stretching, under heat, and allowing them to set in such a stretched condition. This latter stretching treatment is particularly applicable to the thermoplastic fibers. Stretching by either method materially increases the strength and elastic properties of the fiber.

(4) *Product.*—The synthetic fibers are produced in a variety of types and forms, not all of which are applicable to all types of synthetic fibers. The original and basic form is the continuous multiple filament strand, twisted together very loosely. This material may be lustrous, delustered, colored, crimped, highly twisted, or cut into short lengths, as the use for the material may dictate.

(5) The following table gives a comparison of wet and dry tenacity (strength in grams per denier) and elongation of the principal manufactured fibers as compared with silk, wool, and cotton.

		Wool	Silk	Cotton	Viscose	Acetate	Casein	Stretched Vinyon	Stretched Nylon
Tenacity (grams/denier).	Dry	*0. 55	2. 3	*2. 0	2. 0	1. 4	1. 0	4. 0	5. 0
	Wet	*0. 45	1. 85	*2. 2	1. 0	0. 85	0. 51	4. 0	4. 4
Elongation (percent)	Dry	50	18	4	17	20	60	18	20
	Wet	57	26	4. 1	30	34	95	18	30
Elasticity (percent)	Dry	5	3	3	1	1	Plastic	------	4

* Computed average to tenacity in grams per denier.

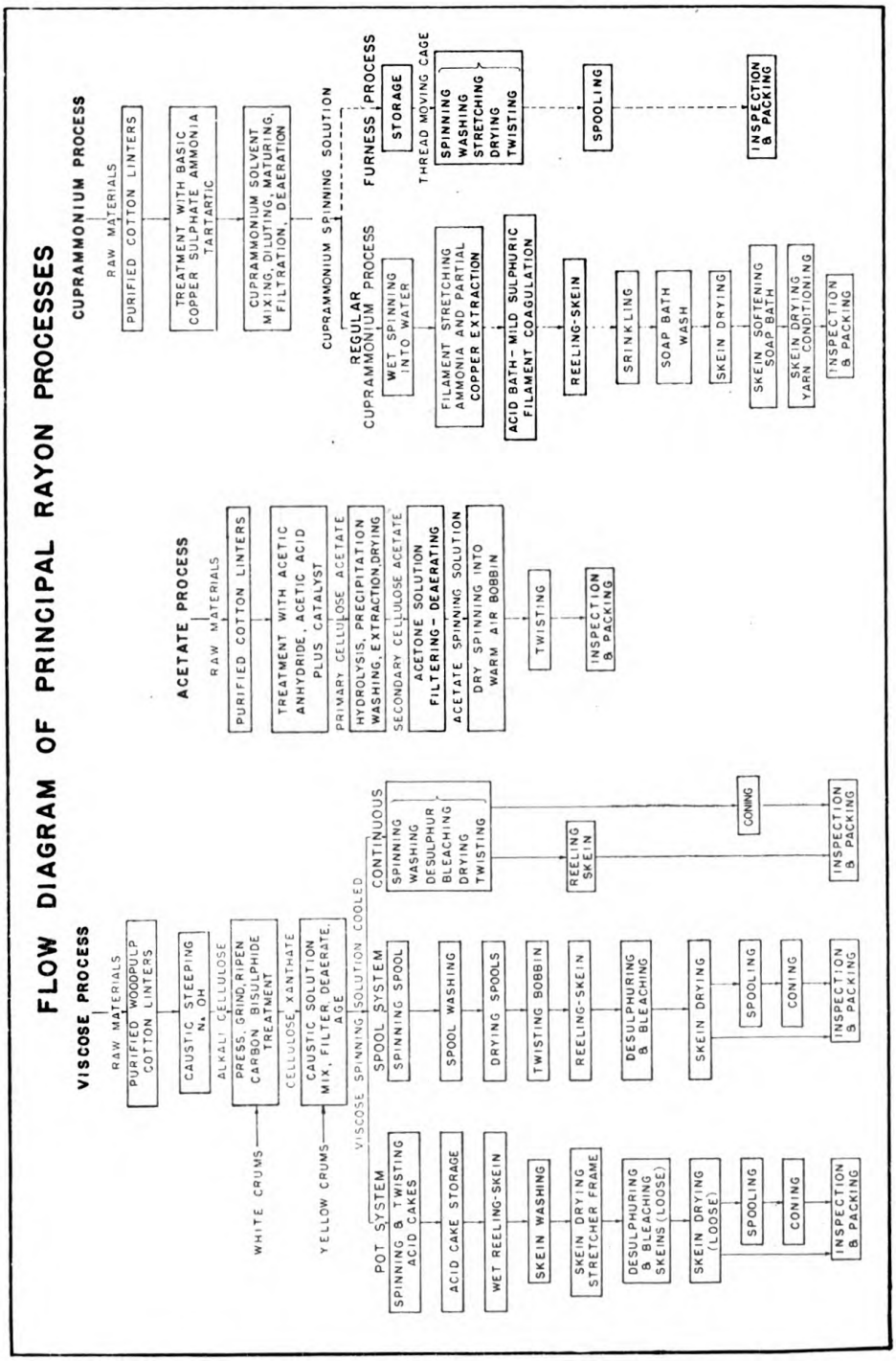
b. Rayon.—(1) The rayons include the fibers manufactured primarily from cellulosic materials, and represent two general types: The regenerated rayons (nitrocellulose, cuprammonium, and viscose) and the cellulose esters (cellulose acetate and cellulose ether). The regenerated celluloses are essentially cellulose or cellulose hydrates coagulated or precipitated out of solutions of alpha cellulose. The cellulose esters are represented primarily by cellulose acetate, which is an acetylated cellulose, an ester of cellulose in its nature of a polyhydric alcohol. A cellulose ether, called ethoraon, has been announced, but is not yet in commercial production (1940). The regenerated cellulose rayons are of greater interest to the Army than the acetate type due to the solubility of the latter in certain solvents. Viscose rayon represents over one-half of the total rayon production, acetate rayon about one-third, and the cuprammonium and nitrocellulose rayons represent the balance. The production of the latter in the United States is negligible.

(2) *General processes of manufacture.*—Cellulose rayons are produced, in general, from purified cotton linters, or from special rayon quality sulfite wood pulp high in alphacellulose content. Linters are widely used for the less important nitrocellulose and cuprammonium yarns and, to some extent, for acetate, but for the viscose, wood pulp is used almost exclusively. Wood pulp is prepared mostly from spruce from the forests of Canada, Scandinavia, and Finland, though beech pulp is quite successfully used in Germany. The preparation consists briefly of stripping the bark, breaking the wood into small chips (about ⅛ by ¾ by ½ in.) and boiling it under pressure with a solution of calcium and magnesium bisulfite, together with some free sulfurous acid for about 18 hours, in order to remove the lignin, natural gums and resins, and the hemicellulose. The pulp is then washed and bleached (sodium hypochlorite), pressed into sheets, and dried to the desired percentage of moisture. These sheets are then cut to standard sizes and baled for the market. Operations through which materials pass in the manufacture of the principal cellulose rayons are shown by the flow diagram.

(3) *Delustering.*—The rayon fiber, as spun normally, possesses a distinct luster. Various methods have been used to dull the luster. The most successful and most widely used method of delustering rayon, consists of the incorporation of finely powdered titanium dioxide in the spinning dope and is applicable to all types. This material is distributed throughout the fiber, where it breaks up the internal reflections of light, and appears on the surface of the fiber, where it breaks up the direct reflections of light, thereby producing a "dull" rayon. Other methods successfully applied include the precipitation of metallic soaps onto the fiber and by abrasion of the surface. The metallic soaps are relatively insoluble but do not provide a permanent finish. The roughening of the surface can be accomplished, with any degree of success, only by chemical treatment or hot soaping, and is then, in general, applicable only to the acetate rayons.

(4) *Staple rayon.*—Rayon as produced is in the form of continuous filaments, usually 40, loosely twisted into strands, and is sold in skeins or on cones. In this form it cannot be used for admixture with cotton or wool as adulterants, or to provide desired characteristics. For such use, it is cut into the desired lengths (stapled) and is then processed mechanically very similarly to the fiber with which it is used.

(5) *Modified (animalized, basified) rayon.*—A modification of recent origin consists of the incorporation of other than cellulosic



materials in the spinning solution in order to modify the dyeing characteristics of the resultant fiber. One method by which the so-called animalized fibers are produced consists of the incorporation of 3 to 4½ percent casein into the spinning solution. Successful application has been made of this method in the viscose process. Another method of obtaining the same object is by the incorporation of certain synthetic resins of a basic nature into the viscose to produce the so-called basified cellulose fibers. Such modified fibers will take the same dyes as those for which wool has an affinity. However, due to the small amount of basic or protein content of the fiber, the same depth of dyeing as that obtained on the wool cannot be hoped for. However, the absorption of a limited amount of the same dyestuff as wool avoids the difficulties of union dyeing (two types of fibers together) and permits the coloring of a mixture of the wool and modified cellulose rayons by use of a single type of dyestuff. In view of the increasing use of rayons for the adulteration of wool and the probable necessity of such adulteration to supplement the supply of wool in the event of an emergency, the possibilities of such materials constitute a distinct advantage.

(6) *Characteristics of rayon.*—The rayons are more lustrous, unless spun "dull," than any other fiber, due to their smooth surfaces, which introduce other difficulties. Rayon filament fabrics are quite liable to seam slippage, due to the readiness with which the crosswise yarns can be slipped toward a cut edge of the fabric. Another very definite disadvantage is their loss in strength when wet as illustrated by the table given in paragraph 13*a* (5). This loss in strength prevents its application to the production of hosiery, which is subject to perspiration, and limits its use to moderate percentages as an adulterant of wool. For military clothing the use of acetate rayon as an adulterant cannot be considered, due to its solubility in certain organic substances. For clothing fabrics either of the regenerated cellulose rayons might be used to supplement the wool supply in the event of an emergency.

c. Vinyl polymers (*Vinyon*).—"Vinyon" is the trade name of a thermoplastic polymeric fiber synthesized from strictly synthetic materials having no fibrous nature as raw materials. The vinyl resins are high molecular weight polymers of vinyl chloride and vinyl acetate. By polymerizing them together, in the proper proportion, a thermoplastic material is obtained which can then be dispersed in acetone to get a spinning dope, which, after filtering and deaerating, is spun the same as acetate by the dry or air spinning process. After

the yarn is conditioned and twisted, it is given a stretch of over 100 percent and set in that condition by several hours immersion in water at 150° F. This stretching gives an increase of 300 percent in strength, or twice that of the rayons. Moreover, it does not lose strength when wet as do the other synthetic fibers with the exception of Nylon. Vinyon is, however, thermoplastic at a temperature of about 150° F., so it cannot be steamed or pressed with heat. In addition, it is soluble in certain organic solvents. It is not suitable for use in military uniform fabrics, but is exceedingly valuable as a filter fabric material, due to its high resistance to many of the very strong acids, and to the caustic alkalis as well.

d. Polyamide polymers (Nylon).—"Nylon" is a generic trade name for a family of high molecular weight polyamide polymers of various dibasic acids and diamine products, and is, like Vinyon, a strictly synthetic fiber produced from nonfibrous raw materials. Nylon may be dissolved in phenol, or as has been found more practical, melted by heat, and extruded through spinnerettes. After cooling, the yarn is stretched to about four times its original length to increase the strength, after which it is coned or skeined for sale. Nylon is thermoplastic, melting at about 475° F., but is not materially affected by heat at much below that temperature. It is similar, chemically, to protein, though it is strictly synthetic. Its high strength and resistance to water make it suitable for use for hosiery. In general, other than for controlled uniform size and strength, it has the same advantages and disadvantages as silk. Nylon is available as continuous filament yarn.

e. Casein (Lanital).—Casein fibers under the trade name of "Lanital" have been on the market since about 1936. The name "Lanital," by which such fibers are widely known, is the Italian name for the fiber; however, each country producing a casein fiber has a different name for it. Casein fibers are prepared from skimmed milk by precipitation of the casein, which is then purified and dissolved in an alkaline solution, aged, and extruded through spinnerettes into an acid bath. The casein globules are distorted and elongated in the spinning bath and are coagulated in that condition in the acid bath to form a fiber which is then hardened by treatment with dilute formaldehyde to render the material relatively insoluble. Casein fibers are similar to wool in reactions to chemical treatment, but are softened by heat and water. Although the casein fibers are not elastic, the material is used as a 30-percent adulterant for military fabrics in Italy.

f. Miscellaneous.—A wide variety of synthetic fibers have been made experimentally, but none have reached commercial importance.

Synthetic fibers include: gelatine silk, formed from solutions of gelatine; a regenerated silk fiber spun from dissolved silk; a fiber, probably similar to gelatine silk, produced from fish scales; regenerated wool (keratin) fibers; and seaweed products. Of the more recent experiments, the protein fibers produced from soybean protein and from a corn protein, zein, in the United States, and from fish protein in Germany, appear promising.

g. Metallic.—The metallic fibers are generally wire or narrow strips of metallic foil rather than fibrous material in the generally accepted sense. Fine metallic wires, usually of gold or silver, or of cheaper metals plated with gold or silver, are frequently used for braids and other ornamental purposes. Tinsel thread is made by spirally twisting narrow strips of metal foil around a textile yarn, producing a brilliant metallic surface, which is useful for ornamental purposes. Metallic effects are obtained by suspensions of metallic powders, such as aluminum, bronze, etc., in cellulose acetate as ribbon-like filaments or as a coating on cotton or silk yarns.

SECTION IV

YARN AND CLOTH CALCULATIONS

14. Yarn count and its determination.—*a.* Yarns are spun so that there is always a fixed relation between weight and length, or, in other words, between the weight of the original fiber and the length of yarn spun from it. This relation between the weight and length is "count" of yarn, or its "number." It is determined by measuring carefully any given length and weighing it. From these results the relation between the two, that is, the count, can be calculated; for example, the number of yards per pound. There are, unfortunately, many systems or different units of measure. No one system is universal, even for the same fiber; nor can one be translated readily into others. The existence of so many systems is due to the fact that the textile industries in their infancy were originally localized, and, owing to the lack of means of communication, trade was restricted. Some effort has been made to obtain some uniformity by the "Typp" system.

b. Yarns are often folded or twisted together to form one coarser thread. Such yarns are commonly known as ply yarns. The method of numbering all ply yarns (except spun silk) is to give the counts of the single yarns that are folded, and place before the counts the

number of yarns folded: thus, 2/40S is made of 2 folds of a single yarn having a count of 40. The new yarn, 2/40S, will have a weight equal in yards per pound of a 1/20S.

c. The following principal systems of yarn standards show the yards per pound in number one count:

Cotton	840 yards per pound.
Spun silk	840 yards per pound.
Worsted	560 yards per pound.
Woolen (run system)	1,600 yards per pound.
Woolen (cut system)	300 yards per pound.
Linen, jute, and ramie	300 yards per pound.
Silk and rayon	450 meters per 0.05 grams.
"Typp" system*	1,000 yards per pound.

*This is the new system adopted by the American Society for Testing Materials.

d. In the measurement of count a suitable length of yarn is measured off, avoiding either tension or slackness, on a reel. For cotton and worsted yarn 120 yards is a convenient length. For raw silk or even, fine cotton counts 240 yards should be reeled. Theoretically, the count should be constant from yard to yard, but in practice this is impossible and considerable variations are encountered.

e. The weight of a given length of yarn is affected by the amount of moisture it contains, and this varies with the humidity of the atmosphere. The determinations of yarn count are made under controlled atmospheric conditions. Examples of problems that are encountered are given below:

(1) *Determination of count.*—(*a*) To find the count of a yarn when the length and weight are given.

1. *Rule.*—Divide the total length of yarn, expressed in yards, by the weight (in pounds) multiplied by the standard length.
2. *Example.*—If 168,000 yards of cotton yarn weigh 5 pounds, what is the count?
3. *Solution.*

$$\frac{168{,}000 \text{ yards}}{5 \text{ pounds} \times 840 \text{ (standard length)}} = 40S$$

(*b*) To find the weight of yarn when the length and count are known.

1. *Rule.*—Divide the length in yards by the count times the standard length.
2. *Example.*—What is the weight of 168,000 yards of number 40S cotton yarn?

3. Solution.

$$\frac{168{,}000 \text{ yards}}{40 \times 840 \text{ (standard length)}} = 5 \text{ pounds}$$

(*c*) To find the weight of ply yarn when the length, ply, and count are known.

1. Rule.—Divide the count by the number of plies. This new figure is multiplied by the standard length, and the whole is divided into the yards.

2. Example.—What is the weight of 224,000 yards of 2/40S worsted yarn?

3. Solution.

$$\frac{224{,}000}{20 \times 560 \text{ (standard length)}} = 20 \text{ pounds}$$

(*d*) To find the length of yarn when the weight and count are known.

1. Rule.—Multiply the weight in pounds, count, and standard together.

2. Example.—What is the length of cotton yarn contained in a bundle that weighs 5 pounds, the count of the yarn being 40?

3. Solution.

40 (count) × 5 (weight in pounds) × 840 standard length) = 168,000 yards

(2) *Equivalent counts.*—Often it is necessary to place the count of a yarn in another system. That is, it may be necessary to learn what the count of a certain cotton yarn would be if it were numbered similarly in the worsted count.

(*a*) *Rule.*—To find the count of one system that is equivalent to that of another, multiply the given count by the number of yards in the standard length and divide the resultant yards by the standard length of the system desired.

(*b*) *Example.*—Find the equivalent of a 2/40 cotton in the worsted count.

(*c*) *Solution.*

$$840 \text{ (standard length)} \times \frac{40}{2} = 16{,}800 \text{ yards per pound}$$

$$\frac{16{,}800 \text{ yards}}{560 \text{ (standard worsted)}} = 30\text{S or } 2/60 \text{ worsted}$$

20

f. In the numbering of all yarns except silk and rayon, the larger the yarn count number the more yards per pound, the fewer pounds per yard, and the smaller the diameter of the yarn. In the numbering of silk and rayon, the larger the yarn count number the fewer yards per pound, the more pounds per yard, and the larger the diameter of the yarn.

g. Sewing threads do not follow the same counts as used for yarns. The number of cotton threads signify that 3 strands of yarn have been twisted together, that is, No. 50 standard sewing thread has 3 strands of No. 50 yarn plied together in it. Such thread is denoted as "3-cord thread."

15. Count of cloth.—*a.* Woven fabrics are made to contain a definite number of warp and filling threads per some unit length. This length, universally used, is 1 inch. The warp is always spoken of first and the filling subsequently. Thus, a count of 116 by 56 shows that there are 116 warp threads to the inch and 56 filling threads to the inch.

b. Knitted cloth which is made from a series of interlacings of one thread does not have a filling yarn, and the texture is expressed in a different manner, as cut, gage, courses per inch, ribs, or wales per inch. (See glossary.)

SECTION V

LABORATORY TESTING

16. General.—Information is often desired on quality, physical properties, chemical constituents, weight and size of yarns and fabrics, and adulterants. Some of the information desired may be surmised or even known in a general way, and greater accuracy or con-

firmation is necessary. For this purpose a laboratory is necessary where standard procedures and conditions can be maintained.

17. Equipment.—The necessary equipment may range from the most complicated pieces of apparatus to the simplest arrangement. No less important than the best equipment, correctly calibrated, is the knowledge and technique of the person operating or making the tests. It is not intended to list every type of testing equipment or test known to science. In a further discussion of the tests it will be noted that the testing will be mainly of two kinds—namely, physical and chemical. It is preferable to have physical testing and chemical testing in two separate rooms—one, where the physical testing is done, to have some arrangement for maintaining constant air conditions (see par. 19), the other to house all equipment for chemical tests. The equipment necessary is dependent on the type of material to be tested and the type of tests to be made. The minimum requirement would consist essentially of the following:

a. Analytical balance sensitivity of 1/20 milligram.

b. Drying oven, thermostatically controlled.

c. Microscope, compound, with low, medium, and high power, and with dry objectives.

d. Tensile strength machines (two)—one for yarns and threads, one for fabrics up to 300-pound strength.

e. Thread counter.

f. Dies for cutting samples, 1, 2, and 4 inches square.

g. A reel, for reeling off measured lengths of yarn or threads.

h. Laundry machine with reversing wash wheel of the cylindrical type.

i. Flat bed presser.

j. Launder-O meter or similar machine.

k. Air-conditioning equipment.

l. Chemical glassware—burrettes, beakers, pipettes, extraction apparatus, etc.

m. Chemicals, reagents of known purity, as U. S. Pharmacopoeia XI or American Chemical Society.

n. Fade-Ometer, or similar apparatus, for testing rapidly fastness to light.

The cost of the equipment listed will be approximately $5,500.00.

18. Sampling.—The importance of correct sampling for any test cannot be overemphasized and repeatedly the question must be asked, "Is the sample representative of the lot?" The amount or size of sample necessary is dependent upon several factors. The sampler must therefore have a good knowledge of the tests to be made and

govern himself accordingly. A few very general statements can be made. Where many containers of raw materials are in question, draw portions from the center or toward the center of several containers. In piece goods the sampling should always be full width of the fabric, and the frequency of sampling may vary from 1 yard every 1,000 yards to 1 yard per every 10,000. Where goods have been baled, do not take a sample from the top or bottom bolt of the bale. Inaccurate results in shrinkage and thread counts are caused by the pressure of the baling wires or straps. The samples correctly labeled are sent to the laboratory for testing.

19. Atmospheric conditions.—Physical testing may be made under prevailing atmospheric conditions, but in the settlement of disputes atmospheric conditions must be controlled. Air, which is the testing medium, contains on different days varying amounts of moisture. All textile fibers absorb large quantities of moisture from the surrounding atmosphere, and this moisture seriously affects the strength and other properties of textiles. The amount of moisture absorbed by a fiber varies from fiber to fiber, that is, cotton will absorb a different amount than wool or rayon. In addition, the moisture content in fibers varies as the amount of moisture varies in the air. If the amount of moisture in the air, at a certain temperature, can be controlled, the amount of moisture in a fiber can be controlled. Experimental tests showed that the best equilibrium between the moisture in the air and the moisture in the fabric is obtained at 65 percent relative humidity at 70° F. A practical tolerance is allowed in relative humidity of plus or minus 2 percent and only plus 10° F. in temperature. The term "relative humidity" requires some explanation. It is the ratio of the amount of moisture in the air to the maximum amount of moisture that the same air could hold, before precipitating, at the same temperature. In other words, when air is at 65 percent relative humidity at 70° F., it contains 65 percent of the amount of moisture that it could hold at 70° F.

20. Determination of relative humidity.—When a wet object is placed in dry air it gives off its moisture. The change of state of water from the liquid state to the vapor state requires energy which can only be obtained by robbing the object of heat. If the object is a wet fabric surrounding a thermometer the amount of energy lost (heat) is proportional to the amount of moisture given off and is registered by the thermometer. If another thermometer is nearby, that has no wet covering, a difference of 2° or more will be noticed. In order to obtain the maximum difference in temperature the air is circulated, or the instrument is moved through the air, at a speed

of 10 to 20 feet per second. From the difference of the temperature of the two thermometers the relative humidity can be calculated from this formula (Smithsonian Meteorological Tables, 1924):

$$e=e'-0.000367\,P(t-t')\left(1+\frac{t'-32}{1571}\right)$$

where e=actual vapor pressure of the atmosphere in inches of mercury.

e'=maximum vapor pressure at temperature t' in inches of mercury.

p=barometric pressure in inches of mercury.

t=dry bulb temperature in degrees F.

t'=wet bulb temperature as shown by the sling psychrometer in degrees F.

When e has been found, the relative humidity may be calculated as follows:

$$\text{Relative humidity (percent)}=\frac{100\,e}{E}$$

where E= saturated or maximum vapor pressure at temperature t. These calculations may be cumbersome, and use is made of prepared tables or charts. Such charts or tables can be found in *Handbook of Chemistry and Physics*, or obtained from the Smithsonian tables, referred to above, air-conditioning manufacturers, or thermometer manufacturers.

21. U. S. Government standards for cotton.—The properties of cotton are grouped into three general quality groups for the purpose of commercial classification:

a. Grade.

(1) *Foreign matter.*

(*a*) Broken leaves.

(*b*) Stems.

(*c*) Seeds.

(*d*) Bracts.

(*e*) Burrs.

(2) *Color.*

(*a*) *Hue.*—Color name, red or yellow.

(*b*) *Brilliance.*—Bright.

(*c*) *Chroma.*—Depth of color; creaminess or stain.

(3) *Preparation.*

(*a*) Normal length of fibers maintained.

(*b*) Regularity in which fibers are laid in ginning.

(*c*) Relative neppiness of the cotton.

b. Staple length.—The length of staple of any cotton will be the normal length by measurement without regard to quality or value of

a typical portion of its fibers under a relative humidity of 65 percent at a temperature of 70° F.

c. Character.

(1) Body.
(2) Uniformity.
(3) Strength.
(4) Fineness.

d. Classification.—To a certain extent cotton is placed on the market, irrespective of fiber length, in certain grades, depending upon its growth, maturity, cleanliness, color, and freedom from insect injury. The Government recognizes nine full grades. Gradations between these grades are marked by experts as "barely", "strictly", and "fully" to represent increasing improvements over the rated grade of the cotton. Starting with the best, the grades are:

No. 1, or Middling Fair.
No. 2, or Strict Good Middling.
No. 3, or Good Middling.
No. 4, or Strict Middling.
No. 5, or Middling.
No. 6, or Strict Low Middling.
No. 7, or Low Middling.
No. 8, or Strict Good Ordinary.
No. 9, or Good Ordinary.

22. Cotton stapling.—*a. Mechanical.*—(1) Increasing in importance is the use of mechanical apparatus in testing fiber length and the length distribution of cotton. The testing is done in standard atmosphere of 65 percent relative humidity at 70° F. The humidity tolerances allowed are ±3 percent relative humidity in the American Society for Testing Materials method and ±2 percent relative humidity in the second supplement of the U. S. Pharmacopoeia XI. The temperature tolerances allowed are ±5° F. in the American Society for Testing Materials method and ±2° F. in the U. S. Pharmacopoeia XI. There is, at present, no applicable Federal specification. For the sake of definitiveness the Suter-Webb apparatus is described. The sorter consists of two banks of combs rigidly mounted side by side on a common base. Each bank of combs consists of at least 12 individual combs spaced one-eighth of an inch apart, one behind the other, and mounted in grooves, so that, as they are approached during the fractionating process and no longer needed, they may be dropped below the working plane. Each individual comb has a single row of accurately alined, sharply pointed teeth one-half inch long. The teeth are 0.015 inch in diameter, 62 to the inch, and cover an extent

of about 2 inches. In addition to the combs, some accessory equipment is necessary, as sorter forceps, fiber depressing grid, fiber depressing smooth plate, and a black velvet covered aluminum plate.

(2) A representative sample is prepared by taking 32 pinches of cotton from the two sides of the bale, or other material to be tested. Mix the pinches promiscuously and combine each pair by gently drawing and lapping them with the fingers; then divide each pair by splitting longitudinally into approximately equal parts, and utilize one part in the further mixing, the other part may be reserved for a recheck or further tests. This process of doubling and splitting is continued until 1 small pinch of about 75 milligrams remain. Gently parallel the fibers and weigh accurately. Place the fibers at right angles to the combs and imbed into the combs with the fiber depressing grid. The few fibers projecting from the first set of combs are gripped by the sorter forceps and drawn from the combs and placed in the *second* bank of combs as parallel as possible and with their front edge as close as possible to the front comb. Continue this operation, depressing the fibers into the combs with the depressor grid, until all fibers have been transferred to the second bank of combs. During the transfer of the fibers, drop the combs of the first bank in succession when and as all the protruding fibers have been removed. Starting at the back of the second bank of combs transfer the cotton fibers back to the *first* bank of combs. After all the fibers have been transferred to the first bank of combs start in the back of the first bank and draw the fibers with the forceps and place the fibers on the velvet covered plate, perpendicularly, along a common base. Do not grip too many fibers at one time in the final operation. It may be necessary to make as many as 10 pulls between each pair of combs. The total number of pulls should be not less than 50 or more, 100 for short (1⅛-inch) staple. Beginning at the long end, measure the lengths of the successive pulls to the nearest eights of an inch. The measurements will be recorded and the pulls classified by their midpoint lengths expressed in sixteenths of an inch. For example, $^{13}/_{16}$ inch would be the length recorded for all pulls falling within the class interval of $^{12}/_{16}$ to $^{14}/_{16}$ inch. The pulls on the velvet board are grouped according to their midpoints, weighed to the nearest 0.05 milligrams, and recorded. From this can be calculated the mean length and standard deviations. All weighings are to be made in a standard atmosphere.

b. Manual.—In the field and places where stapling apparatus is not available, stapling is done by hand. For this purpose a handful of cotton is extracted from the bale or bales at numerous points; this

is thoroughly mixed together, the mass is broken in half, and a large number of "pinches" or samples are then taken. These pinches are paralleled between the thumb and fingers of both hands and superimposed upon themselves. After the fibers are fairly parallel, the ends of the fibers are placed in line, or "blocked off," and then measured with a ruler. Naturally, it is neither the longest nor the shortest, nor the precise average which is desired. The point where a given length of fiber forms an opaque mass when "blocked off" is regarded as the staple length of the batch. This method, in spite of variations in the technique of the person making the test, will be used for some time.

23. U. S. Government standards and classification.—*a. Cotton linters.*—(1) Linters are the vegetable hair removed from cotton in processes *subsequent* to usual processes of ginning. This hair, or residual fibers called "linters," is recovered by intensive ginning, or delinting as a step in the preparation of cottonseed for crushing. The cottonseed has 5 percent to 16 percent residual fiber by weight, depending upon the type of seed and care exercised in the original ginning.

(2) Linters are a mixture of two types of fibers—the long, usually soft or flaccid fibers that may have escaped removal during ginning, and the very short, more deeply colored fibers or fuzz that are found more or less densely matted about the seed coat at the base of the long fibers of American upland varieties of cotton. Linters that contain a large portion of the long type of fiber are distinguished from commercial cotton only by their softness and color. As the proportion of long fibers decreases and the proportion of short fibers or fuzz increases, linters begin to assume the color of fuzz. There is, therefore, a considerable range of color in linters. Buff seems to be the base.

(3) Delinting is generally spoken of as "cutting." Cuts range from 20 to 50 pounds per ton of seed, and have generally become known as "first cuts" or "first cut linters." Cuts ranging from about 35 to 100 pounds or more per ton of seed are known as "mill runs" or "mill run linters." After a first cutting, especially if not over 35 pounds per ton of seed have been removed in the first delinting, the seeds are frequently passed through the linter machine a second time. These linters are known as "second cuts." The total amount of linters cut ranges from 30 pounds to 200 pounds per ton of seed. Fibers recovered from the hulls by a special process, after decortication, produce a grade of linters known as "hull fiber."

(4) The official standard grades and classification for American cotton linters are prepared by the Department of Agriculture and

preserved in boxes for comparison with the sample. These grades are 1, 2, 3, 4, 5, 6, 7, and hull fiber. The classification is as follows:

- Staple
  - Long fibers
  - Fuzz
- Foreign matter
  - Hull particles
  - Motes
  - Broken leaves
  - Sticks
  - Dirt
- Color
  - Natural
    - Buff
    - Olive
  - Unnatural
    - Weather damage
    - Fungus stains
- Character
  - Length
    - Maximum
    - Uniformity
  - Resiliency
    - Softness
    - Harshness
  - Smoothness or neppiness

b. Wool.—(1) There are several commercially known and used methods in describing the grade of wool. The descriptive terms are all based on the diameters of the fibers. The American classification was originally based on the wool from a full-blooded merino sheep, as the standard of fineness, and other grades were arranged according to the amount of merino blood present. In this method, the wool from a half-blooded sheep would be twice as coarse as the wool from a full-blooded merino sheep. While the grade terms are still retained, they do not carry the former meaning. The terms to-day bear no relationship to the amount of merino blood present in the sheep producing the wool. Many ½-blood, ⅜-blood, and ¼-blood wools are grown by sheep containing no trace of merino blood.

(2) The official standard wool samples are prepared by the U. S. Department of Agriculture and use the numerical British classification; the standards are kept by various government departments and manufacturers for reference.

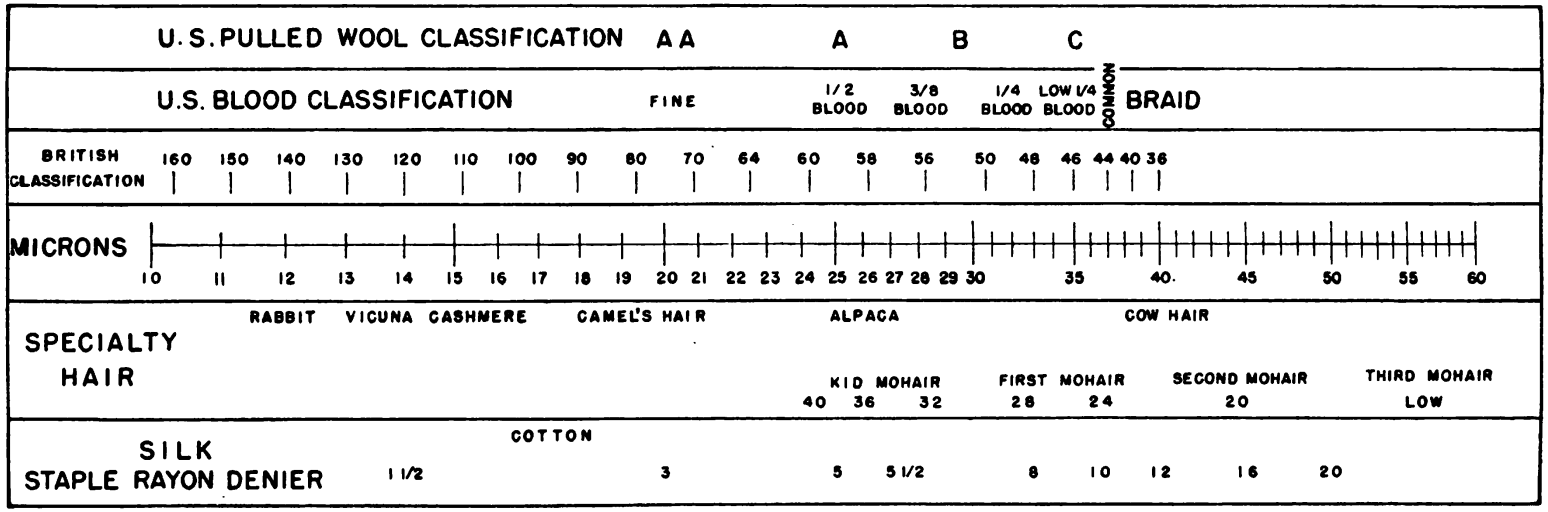
(3) Pulled wool is classified according to an alphabetical listing.

(4 Recently, a more scientific grading has been developed and adopted by the American Society for Testing Materials, and is known as the wedge method or the cross section method.

(5) A comparison of the various methods of grading is shown in the table on page 29.

(6) A new system of wool grading has been developed by Von Bergen and Hardy. The methods of test are applicable to wool in loose form, top, or roving. These methods project the image of the

COMPARATIVE SCALE FOR FINENESS OF VARIOUS TEXTILE FIBERS



AVERAGE WIDTH RANGES FOR VARIOUS FIBERS[1]

1. *Wool top, United States and American Society for Testing Materials standards*

Grade		Fineness range (microns)
Fine	80's	18.5 to 19.5
	70's	20.0 to 21.0
	64's	21.5 to 22.5
½ blood	60's	24.5 to 25.5
⅜ blood	58's	26.0 to 27.0
¼ blood	56's	27.5 to 29.0
	50's	30.0 to 31.5
	48's	32.0 to 33.0
Low ¼ blood	46's	34.0 to 35.0
Common	44's	35.5 to 36.5
Braid	40's	37.5 to 38.5
	36's	39.0 to 41.0

2. *Rayon*

	Fineness range (microns)
1½ denier	14.0 to 15.0
3 denier	19.0 to 21.0
5 denier	24.0 to 26.0
10 denier	35.0 to 38.0

3. *Mohair*

	Fineness range (microns)
Kid	24.0 to 30.0
First	30.0 to 40.0
Second	40.0 to 50.0
Third	50.0 to 60.0

4. *Specialty hair and miscellaneous fibers*

	Fineness range (microns)
Rabbit	12.0 to 15.0
Vicuna	13.0 to 14.0
Cashmere	15.0 to 16.0
Camel hair, fine	17.0 to 20.0
Alpaca	25.0 to 29.0
Silk	9.0 to 11.0
Cotton	16.0 to 20.0

[1] All results were obtained by the width method as described in the Standard Methods of Test for Fineness of Wool (D 419-37) and the Tentative Specifications and Methods for Test for Fineness of Wool Tops (D 472-37 T) of the American Society for Testing Materials.

fibers either longitudinally or in cross section upon a wedge which bears a known relation to the actual magnification in the microscope. The samples, thoroughly cleaned, are well mixed. The sliver for test should be about 2 inches in length and contain about 120 fibers. This sliver of fibers is mounted on a microscope slide, embedded in chemically pure glycerol, and covered with a cover glass. The slide, with the mounted sample, is placed in the stage of a microscope. The magnification used is 500 times. The image of the fibers is projected on a wedge of definite dimensions. The wedge is turned until the width of the wedge coincides with the width of one fiber. This point is marked on the wedge with a dot or a small line. Other fibers are projected on the wedge until the width of 100 fibers has been obtained.

After the necessary number of fibers have been marked off, the wedge is ruled in segments of 2.5 microns and the number of fibers in each segment counted. As 100 fibers are taken, this results in a direct percentage reading. The frequency of a fiber within a certain measurement determines the grade of the wool. The table on page 31, shows the U. S. Government requirement for wool tops effective January 1, 1940.

(7) There is also a tentative standard for determining the fiber length of wool in the American Society for Testing Materials designation D 519–38T. The principle of the machine is similar to that of the stapling machine described in paragraph 22*a*. However, the spacing of the combs is different, and the cotton stapling machine cannot be used for wool stapling.

24. Microscopic examination of fibers.—*a.* The examination of textile fibers is very important, and a knowledge of the use of microscope and the technique and skill in preparing specimens can be acquired only by actual long-term working with the materials. Only a slight description of a microscope will be given. It consists of a heavy frame, called a stand, and has a platform or stage for placing the sample. Below the stage there is a mirror for collecting and changing the direction of the light into a series of lenses known as a condenser. The amount of light passing through the condenser is regulated by a diaphragm or iris. The whole condenser and iris may be raised or lowered, depending on the amount of light desired. Too much light will also make some of the details of the specimen disappear. Above the stage there is a vertical tube, with a series of lenses at both ends. These lenses magnify the specimen on the stage. Depending on the position of the lenses, they are known as objectives, because they are near the object, or oculars, because they

are near the eye of the observer. The tube, with its lens arrangement, can be raised or lowered to bring it into focus of the specimen on the stage. Excessive magnification is not necessary and a total magnification of 100 is sufficient for most fibers. It is well to have a microscope set fitted with a set of objectives mounted in a revolving nosepiece. The fiber is first picked up with the low power and then observed with a suitable high-powered objective.

b. It is desirable, and at times necessary, for the analyst to have authentic samples, permanently mounted on glass slides, of the fibers likely to occur in the textiles he is called upon to analyze. The presence of coloring matter, dyes, finishes, starch, and oils at times will prevent the formation of distinct reactions with various reagents. It is necessary to remove these by gently heating the fibers in a solution of 0.5 percent sodium hydroxide and washing well by squeezing with the hand to remove all caustic. Small samples of the fiber are teased apart with needles and treated with reagents and covered with a cover glass.

U. S. Government requirements for wool tops

[Amendment of official U. S. standards for grades of wool tops. Effective on and after January 1, 1940]

Grade	80's	70's	64's	62's	60's	58's	56's	50's
Fineness range (microns):								
Minimum	18. 1	19. 6	21. 1	22. 6	24. 1	25. 6	27. 1	29. 1
Maximum	19. 5	21. 0	22. 5	24. 0	25. 5	27. 0	29. 0	31. 5
Fibers, percent:								
10 to 20 microns, inclusive, minimum	60	50	36	27	18	16	9	4
10 to 25 microns, inclusive, minimum	92	84	-----	-----	-----	-----	-----	-----
10 to 30 microns, inclusive, minimum	-----	-----	94	88	83	74	64	45
25.1 to 30 microns, inclusive, maximum	8	-----	-----	-----	-----	-----	-----	-----
25.1 to 40 microns, inclusive, maximum	-----	16	-----	-----	-----	-----	-----	-----
30.1 to 40 microns, inclusive, maximum	0. 25 (0.5)	2	6	12	17	-----	-----	-----
30.1 to 50 microns, inclusive, maximum	-----	-----	-----	-----	-----	26	36	55
40.1 to 50 microns, inclusive maximum	-----	0. 25 (0. 5)	0. 33 (1)	0. 50 (1)	0. 50 (1)	2	5	10
50.1 and over microns, maximum	-----	-----	-----	-----	-----	0. 75 (1. 5)	1 (2)	1. 25 (2. 5)
Minimum number of fibers required for test, per sample	400	400	600	600	800	800	1, 200	1, 200

NOTE.—Numbers in parentheses represent maximum percentage of fibers of that range permissible in substandard grades.

c. The reagents necessary for some tests are—

(1) *Herzberg's solution.*

Solution A:

Zinc chloride	50 grams.
Distilled water	25 milliliters.

Specific gravity at 28° C. should be 1.8.

Solution B:

Potassium iodide	5.25 grams.
Iodine	0.25 gram.
Distilled water	12.5 milliliters.

Add solution B to solution A; stir; let stand over night; decant from sediment; add a leaf of iodine; keep in dark bottle.

It is a good general stain for all fibers. Linen, cotton, hemp, and ramie are stained red; jute, sisal, and other lignified fibers, yellow. De-lignified fibers and cellulose are stained blue.

(2) *Millon's reagent.*—Dissolve mercury in an equal weight of cold, fuming HNO_3 (sp. gr. 1.4); then apply moderate heat. Dilute solution with 2 volumes of water. This reagent colors true silk fibers (or other animal fibers, such as wool, mohair, and fur) pink. Vegetable fibers are not stained.

d. In a preliminary test considerable information may be obtained if a burning match is held to a few fibers. The tests show the following:

Fibers do not burn	Asbestos.
Fibers do not burn, but melt slightly	Glass.
Odor of burned feathers or hair:	
Knob forms on end of filter	Silk or wool.
Ash retains shape of thread	Weighted silk.
Burns readily with distinctive odor; knob at end of thread hard	Acetate rayon.
Burns like paper; no odor; ash shapeless; falls off	Cotton, linen, jute, or rayon other than acetate.

e. After being stained with Herzberg's stain, the fibers are examined under the microscope. If the fibers are—

(1) Yellow, white, or greenish—

(*a*) Distinctly pointed at end, with narrow lumen; bright golden yellow ---------- Jute.

(*b*) Fibers of indeterminate length with cut ends; fibers fine with longitudinal striation without cellular structure, transparent, and sometimes parallel diagonal lines_____ Wild or cultivated silk.

(*c*) Fibers larger, rod-shaped with prominent scales; medulla usually absent; stain well with Millon's reagent_____ Wool.

(2) Reddish or purple—

(*a*) Fibers cylindrical; pointed at ends, with cross marks on surface; swollen nodes and narrow lumen_____ Linen.

(*b*) Fibers without above characteristics.

1. Fibers ribbon-like, frequently twisted, with broad lumen_____ Cotton.

2. Fibers without any lumen, straight_____ Rayons.

(a) Dissolves in acetone_____ Acetate rayon.

(b) Dyes a deep orange with 0.2 percent solution of Erie Fast Orange CG (color index 621)_____ Cuprammonium rayon.

(c) Does not dye, or only weakly_____ Viscose rayon.

25. Quantitative separation of fibers by chemical means.—There are several methods of determining the fiber content of a fabric. It is assumed that the analyst knows from qualitative tests, or other information, the presence or absence of certain fibers, and he may eliminate in his analytical procedure some steps. With the development of new synthetic fibers, new methods of analysis must be developed, or the method in use modified.

a. Moisture content.—As a preliminary test, it may be desirous to know the actual moisture content of the fabric. For this information from 5 to 10 grams of the sample is weighed in a previously dried weighing bottle and dried to constant weight in an oven at 105° to 110° C. (221° to 230° F.) for several hours to constant weight. The dry weight of the sample having been determined, further steps in the analysis are taken using this dry weight as a basis.

b. Total sizing, finishing, and other non-fibrous materials.—Starch, china clay, soaps, and some waxes are added to textile fabrics for various purposes, which may be to give a particular finish as in a cretonne, a softness of handle, water-repellent or waterproof finish as in tent duck, or an adulterant or "make-weight". The moisture-

free sample weighing from 5 to 10 grams is extracted with chloroform, or carbon tetrachloride, or other suitable solvent in a Soxhlet, or similar apparatus, for several hours to remove fats and waxes. If the weight of solvent-extracted material is desired, this may be determined either by weighing the extract, without the solvent, or by weighing the sample again after all the moisture and excess solvent has been driven off. The usual method is to weigh the extract. The sample is now treated with a starch and protein solubilizing enzyme, being washed well and dried to constant weight. In plants where equipment is not available, the lack of good laboratory equipment may require modification of the method. However, wherever possible the official method as outlined in Federal Specification CCC-T-191a for Textiles, Test Methods, should be used. A rough determination of sizing can be made by boiling the sample in a 1 percent solution of hydrochloric acid. This removes the starches and other acid soluble material. Alternate washing and squeezing in alcohol and ether will remove oils and waxes. Inert fillers can be removed by mechanical agitation and alternate washing with a hot soap solution.

c. Cellulose acetate rayon.—If acetate rayon is present, the moisture-free weighed sample is treated with 50 times its weight in acetone for about 15 minutes. The sample is well agitated. The residue is treated again with fresh portions of acetone and finally water. The sample is dried (moisure-free) and weighed. The difference in weight will give the amount of cellulose acetate. In a similar manner some of the newer fibers made from polymerized vinyl compounds, cellulose ethers, can be separated by the selection of another solvent.

d. Silk.—The moisture-free weighed sample from the above may be treated by either of two methods. If silk is the main constituent, then the sample is treated with 2 percent hydrofluoric acid and 2 percent hydrochloric acid for 20 minutes at a temperature of 131° F. After washing well with warm, distilled water, the sample is given two treatments with the acids listed above, and washed well. The residue is dried (moisure-free) and ashed. The weight of the ash is deducted from the residue and the percentage of silk calculated on the weight of the moisture-free sample used. In the second method, the extraction is made with a very carefully controlled concentration and temperature of a solution of calcium thiocyanate $Ca(CNS)_2$ and acetic acid. The specific gravity should be 1.20 to 1.21 at 158° F. (70° C.). The treatment of the sample with the calcium thiocyanate solution is repeated. This solution dissolves the silk and the amount of silk present can be calculated by the difference in weight of sample taken and the weight of the residue. This second

method is new and is classed as tentative by the American Society for Testing Materials.

e. Regenerated cellulose rayon.—The separation of viscose or cuprammonium cellulose from other fibers is difficult, if one of the fibers is cotton. A recent tentative method of analysis used by the American Society for Testing Materials is as follows:

The weighed, moisture-free sample is treated with a more concentrated solution of calcium thiocyanate and acetic acid. The calcium thiocyanate solution shall have a specific gravity of 1.35 to 1.36 at a temperature of 158° F. (70° C.), and the treatment of the sample is the same as that given under the second method for silk. The calcium thiocyanate dissolves the rayon and the residue is weighed. The difference in weight between the test sample and the residue is the amount of rayon present.

f. Wool and cotton.—The separation of these fibers is the easiest and best known of any of the fiber separations. There are three methods known and used. In one method, the wool is dissolved and the cotton residue weighed. This is the separation with caustic, or sodium hydroxide. In the two other methods, the cotton is destroyed by an acid, or an acid-producing salt, and the wool is weighed as the residue. The quickest method used is to boil the moisture-free sample for 10 minutes in 5 percent solution of sodium hydroxide and filter the mass through a fine mesh nickel alloy screen. The residue is washed with hot water and 5 percent acetic acid, washed again with water, then dried and weighed. The results obtained with this method are a little high for wool. However, because of the ease in performing the test and its rapidity, the test is often used in daily control work. If there is any dispute in the percentage content of fibers, the separation will be made with sulfuric acid. The sulfuric acid method is given in Federal Specification CCC–T–191a Textiles, Test Methods. The moisure-free weighed sample is treated with 200 milliliters of a 1 percent sulfuric acid solution for 7 to 10 minutes, filtered, and then treated with 200 milliliters of 70 percent sulfuric acid at 100° F. for 15 minutes. The residue is collected in a fritted glass filter and washed with water, sodium bicarbonate solution, and water, in the order named. The residue, which is wool, is dried to constant weight and weighed. The third method uses the property of aluminum chloride of hydrolyzing at dry heat with the liberation of free hydrochloric acid. This free acid carbonizes the cotton; this breaks up into a fine powder and is rubbed from the wool residue. The wool residue is treated with a 3.5 percent solution of hydrochloric acid, washed through a screen, dried, and weighed. The difference

in weight between the moisture-free specimen used and the weight of wool residue gives the amount of cotton in the sample.

g. Lanital.—This fiber originated in Italy and has appeared on the market. The fiber is made from the casein of milk. The product being nitrogeneous, the reactions and solubility are much the same as that for wool. This makes its separation from wool rather difficult. At present the separation from wool is made by flotation process, whereby the Lanital fibers are floated in an inert solvent, and the wool, with a higher specific gravity, falls to the bottom. The liquid used is a mixture of carbon tetrachloride (5 parts) and toluene (3 parts), and the final gravity of this mixture should be 1.310 at room temperature. The sample should be cut very fine and well agitated in the liquid. For greater details of this proposed method see the American Society for Testing Materials on Textile Materials (Committee D-13) October 1939, page 252.

26. Color fastness.—*a. General.*—Many groups and trade organizations have developed and adopted standards for the evaluation of the various types of color fastness, depending on the phase of fastness they are interested in. It is not desired to make a comparison of these methods for evaluating each property, but, as this manual is written for use by a Government organization, the Federal Specification CCC-T-191a for Textiles, Test Methods, is used as a basis. Therefore, in discussing a test it is well to ascertain whether the tests were made in accordance with the Federal specification or some other standard test. The fastness of fabrics is rated on the basis of comparison with the original piece and/or a former satisfactory purchase. There are three ratings on fastness: Good, showing no appreciable alteration; fair, appreciable but not objectionable alteration of color; and poor, objectionable alternation in color.

b. Light.—The best fastness to light test is exposure to the direct rays of the sun under glass. However, this test has one serious drawback—that the intensity of the sun's rays varies from day to day, season to season, and from one geograpical location to another. To avoid some of the difficulties encountered, and obtain some uniformity in tests, an artificial source of light is used which is rich in ultraviolet rays. The whole apparatus is known as a Fade-Ometer, and accelerates results obtained in sun exposure. The results of the artificial exposure and sun exposure cannot be compared directly and it is necessary to specify which of the two tests is to be used.

c. Weather.—This test is similar to the exposure to sunlight except that the sample is exposed unprotected by glass. There is no official

equivalent exposure to artificial light, although an apparatus for that purpose is known and called a Weather-Ometer.

d. Laundering (washing).—The method of procedure varies with the kind of fabric. The procedure of the shrinkage test may be used as a substitute test for fastness in laundering. Without going into the details of the test as described in the Federal Specification CCC–T–191a, it is the rule that the laundering test on cotton fibers is more severe than on woolen fabrics, both in the alkalinity of the solutions used, the length of time treated, and the temperature of water. This is due to two factors, one is that cotton can stand a more severe treatment, and is given a more severe treatment by consumers, while wool would deteriorate under the treatment, and the consumer does not treat it so harshly.

e. Water.—This is the mildest test. The colored sample is wrapped with a piece of undyed cotton, wool, silk, or rayon and immersed for one hour in water at room temperature. The samples are removed and dried and the staining of the undyed pieces, as well as the discoloration of the water, are noted.

f. Salt water and soap.—This test is very infrequently used by the Army, and is similar in procedure to the fastness to water except that the water contains 3 percent sodium chloride (common salt), 0.5 percent magnesium chloride, and 1 percent salt water soap. The temperature of the water is ordinary room temperature, and the time of immersion 1 hour.

g. Rubbing.—This is another test used infrequently by the Army, but well-known commercially. The dyed samples are rubbed either with a dry piece of fine desized bleached print cloth, or a similar piece moistened. The pressure applied to the rubbing, the distance rubbed, and also the rate of rubbing are controlled. A machine for that purpose has been built, and is known as the "Crock Meter."

h. Perspiration.—The perspiration of the human body is rather voluminous, but not sufficient in quantity to collect, and the composition varies from person to person. For uniformity in testing, two artificial perspiration solutions are used; one is acid, and the other alkaline. The dyed samples to be tested are wrapped with pieces of an undyed cotton-worsted (wool) union material. One piece is immersed in the acid solution, and the other in the alkaline solution. After thorough wetting out the samples are rolled and placed in a test tube. The test samples are gradually dried out in a moisture-deficient atmosphere. This will take about 48 hours, and the samples should be dry when observed.

i. Laundering agents containing active chlorine.—This test is very important in Army testing, as it is destructive to many classes of dyestuffs, and only the best dyestuffs are not affected. The sample is immersed for 1 hour at room temperature in a sodium hypochlorite solution containing 0.7 percent available chlorine. There are numerous proprietary preparations on the market which, when correctly diluted, will give the desired strength.

j. Soap and soda.—These are two tests which have no counterpart in the Federal Specification CCC–T–191a. They are extensively used in testing color fastness of cotton, wool, and mixtures of the two fibers. The soap test is made by immersing a small sample in a boiling solution of 80 grains of pure soap in 1 pint of water. The sample is boiled in the solution for 10 minutes and then removed, washed, and dried. The loss in color is compared with the original piece or a piece of the standard fabric similarly treated. The soda test is made by immersing a small sample in a boiling solution of 10 grains of soda ash (Na_2CO_3) in 1 pint of water. The sample is boiled for 10 minutes in the solution and then removed, washed, and dried. The loss in color is compared with the original piece or pieces of the standard fabric similarly treated.

27. Shrinkage in laundering and sponging.—The knowledge of how much a fabric will shrink is very important because a garment when made up from unshrunk material may shrink to such a degree that the garment may be too small for the wearer after several washings. From another angle, lack of the limitation of the amount of shrinkage can be regarded as adulteration, because cloth is purchased on the basis of yards. The test for shrinkage has been closely prescribed. Depending on the purpose of the test, the shrinkage test can be classified into the following three sections:

a. Shrinkage in laundering of cotton textiles.
b. Shrinkage in laundering of woolen textiles.
c. Shrinkage in sponging of woolen textiles.

The samples required for these tests are rather large and should be not less than 24 inches square. In the test a piece is marked off at various intervals in the length (warp) and the width (filling). The markings should be at least 18 inches apart. The cloth is given the laundry treatment under the required specification (Federal Specification CCC–T–191a; Textiles, Test Methods). After the sample has been given the necessary treatment of soap, hot water, and mechanical agitation, it is dried and pressed flat, preferably with a flat bed

presser to avoid any stretching, and measured. The loss in length between the markings (18 inches apart) is used to calculate the percentage of shrinkage. In sponging woolen fabrics there is no soap or hot water used, and the mechanical agitation is only limited to the amount necessary to saturate the fabric. This agitation is usually done by hand.

28. Water repellency and waterproofing.—These two terms are often used synonymously, but the two terms have different meanings. "Water-repellent" means that it will shed water when it falls, or rolls on it. The term "waterproof" means actually impervious to water, like a rubberized fabric. Considerable confusion exists as to where the line can be drawn between water-repellent and waterproof. There are several test methods known. In the one system a piece of the fabric is clamped down under a vertical well. Water pressure is gradually applied at the rate of 1 centimeter per second until the first drop appears through the cloth. A hydrostatic pressure of 17 centimeters is regarded as water-repellent. A resistance of 50 centimeters is regarded as rain-resistant, and a resistance of 50 centimeters for 1 hour is regarded as waterproof. In the other apparatus, outlined in Federal Specification CCC–T–191a, a box with an open side is used. The cloth is clamped on the open side and a definite height (20½ in.) of water is maintained. The water which passes through the fabric in a certain time is collected in a graduated cylinder and observed. In addition, the distance from the top of the surface of the water to that which water comes through is measured.

29. Air permeability.—The Bureau of Standards has made a study of air permeability. A closed container with a fan or blower is divided into two sections by the fabric to be tested. An air current from the blower in one section is forced through the fabric, and the drop in pressure in the second section is used as a measure of air permeability. The details of the apparatus are given in Federal Specification CCC–T–191a.

30. Strength tests.—Woven fabrics are tested in a conditioned atmosphere to obtain the maximum strength. In Federal Specification CCC–T–191a two methods are given, one known as the grab method and the other the strip method. The grab method is preferred to the strip method and is used on army fabrics. The machine used in either case is the same and is known as the pendulum type of machine. The difference between the two methods is in the preparation of the sample and the dimensions of the jaw. The test specimen

is clamped in the jaws and gradually broken by the application of a force at the rate of 12 inches per minute plus or minus 2 inches per minute. The ideal break is one that does not break jagged across and does not break at the jaws. If a specimen slips in the jaws, or, for any reason attributable to faulty operation, falls markedly below the average for the set, the result is disregarded, another specimen taken, and the result of this break included in the average of five breaks.

31. Shading.—This is one branch of testing that, in spite of numerous attempts to develop mechanical testing devices, is still done by the human eye. The color sensitivity of the person who does the shading must be normal for all colors. Shading, therefore, is not a field where the commodity can be gaged with a micrometer, and a certain tolerance must be allowed. In the judgment of the person doing the shading, this question can be asked, "How will this shade look when made into a garment and compare in color with many other garments worn by Army men at the same time?" Commercially, garments will rarely be found with such close demands on shade as the Army requires. The room for shading should have a good north light and should be free from exposure to the direct rays of the sun and free from interfering color reflections from walls or buildings that may be opposite the window.

SECTION VI

DYESTUFFS

32. Selection.—Dyestuffs which are the chemical compounds used to color fibers may be selected for some particular property, as fastness to light, weather, chlorine, perspiration, boiling soap, etc. For these many purposes there are several thousand dyestuffs known. Some dye several fibers, and others will dye only one fiber. For the purpose of this very brief description of dyestuffs, they will be divided into those primarily used for cotton and those used for wool. It is not to be inferred that some cotton dyestuffs cannot be used on wool, or vice versa. Within the cotton dyestuffs there are several classes known, depending on the method of application. The same condition is found in the wool dyestuffs.

33. Cotton.—*a. Vat and leuco vat.*—As a class, these are the most satisfactory for Army use. They are produced in the United States and can be found in all shades. Sunlight, weather, and washing do not affect them appreciably. The leuco vat (Indigosol) are vat colors that have been solubilized and are applied from an acid solution and subsequently developed into an insoluble form on the fiber. These are quite expensive, and used chiefly on fine prints.

b. Naphthols and Rapidogene.—For Army purposes naphthols are also very satisfactory, but no bright blue or bright green colors can be obtained. The brightest reds and yellows, however, are obtainable from them. Rapidogene dyes are used solely in printing cotton fabrics.

c. Developed.—This is a medium-priced class of dye and for purposes where the cloth does not get severe use it is quite satisfactory. All shades are obtainable but are fairly full.

d. Sulfur.—For dull shades, including olive drab and khaki, sulfur dyes are fairly satisfactory. It is necessary, however, to aftertreat such dyes with potassium bichromate and acetic acid to increase the fastness to washing and with copper sulfate to increase the fastness to light. Sulfur-dyed fabrics become tender if stored for great length of time. These dyes, however, penetrate tightly woven fabrics to a greater extent than other dyes because of the alkalinity of the dye solution and the high temperature of the dye bath.

e. Direct.—Direct dyes are divided into two classes—namely, regular directs and fast-to-light directs. Regular directs are very fugitive and are not recommended for Army use. Fast-to-light directs are very satisfactory but will not stand washing. All shades may be obtained from either type. For most directs aftertreating with copper sulfate will increase the fastness to light and aftertreating with potassium bichromate or formaldehyde will increase the fastness to washing.

f. Mineral.—Mineral dyes produce only dull shades, give the fabrics a harsh feel, and cause the needle to break in sewing.

g. Basic.—Basic dyes are as bright as vat dyes, as they are very fugitive, they are not recommended for Army use. All shades may be obtained.

h. Aniline.—Aniline black (either copper or prussiate) is a very good dye but only blacks and grays may be obtained. Fabrics become tender when dyed with this dye and stored for any period of time. Aniline dyes are also poisonous if allowed to come in contact with an open wound. Their use, consequently, is limited.

i. Natural.—There are numerous natural dyes, such as logwood, cutch, sumac, cochineal, etc. Logwood is the only one used to any extent. It is not recommended for Army use.

34. Wool.—*a. Vat and leuco vat.*—For Army purposes these are a satisfactory class of dyes for wool as well as cotton. Any shade may be obtained. They are not as fast on wool, however, as they are on cotton.

b. Chrome (chrome bottom, after chrome, metachrome, and alizarine).—For dyeing wool, these dyes are most extensively used. All shades may be obtained, but are duller than the vat dyes.

c. Neutral dyeing acid.—These dyes are not recommended for Army use, as they are fugitive. All shades and bright shades may be obtained.

d. Direct (union).—All shades may be produced by these dyes, but they are dull. They are not recommended for Army use, as such dyes are fugitive.

e. Acid and stronger acid.—The ordinary acid colors give very bright shades and all shades are obtainable. The colors are fugitive and not recommended for Army use. Newer dyes (Neolan or Glycolan) have appeared in the market which have better fastness and can be used for Army purposes.

f. Basic.—Very bright shades and all shades can be obtained. These are very fugitive and not recommended for Army use.

g. It is possible to produce all types of dyestuffs in this country with the exception of naphthol, rapidogene, and indigocols colors. These latter colors are controlled by foreign patents, but in a time of emergency all types of dyestuffs may be produced here. The operation of dyeing in the raw stock is considered to be cheaper than dyeing in the yarn form or in the woven piece. Raw-stock dyeing gives better penetration of the dyestuff and more uniform shades may be produced. However, by dyeing in the raw stock, all the wastes in combing and spinning are dye and, consequently, their resale value or re-utilization value is considerably reduced, making the over-all costs run equal to if not greater than the other types of dyeing operation.

Various types of dyes for cotton and their fastness characteristics

Price [1] class	Type of dye	Home washing	Laundry	Light	Slasher sizing	Bleaching (chlorine)	Gross dyeing	Mercerizing	Cost of application [2]
1	Leuco vat	Excellent	Excellent	Very good	Excellent	Excellent	Excellent	Excellent	*C*
2	Vat	Excellent	Excellent	Very good	Excellent	Excellent	Excellent	Excellent	*A*
3	Naphthol and Rapidogene.	Excellent	Excellent	Very good	Excellent	Good	Excellent	Excellent	*B*
4	Direct (fast to light).	Good in light shades, poor on heavy shades.	Poor	Very good	Good in light shades; heavy shades require care.	Bad	Bad	Some good	*J*
5	Developed	Good	Good to fair	Fair	Good	Bad	Bad	Fair	*D*
6	Sulfur	Good	Good	Fair to good	Excellent	Bad	Good	Good	*I*
7	Direct	Good in light shades, poor on heavy shades.	Poor	Fair	Good in light shades; heavy shades require care.	Bad	Bad	Some good	*K*
8	Mineral	Excellent	Excellent	Very good	Excellent	Excellent	Excellent	Excellent	*E*
9	Basic	Fair	Fair	Very poor	Require extreme care.	Bad	Bad	Bad	*G*
10	Aniline	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	*F*
11	Natural	Poor to good	Poor to fair	Fair	Fair	Bad	Bad	Bad	*H*

[1] The numbers indicate the price class. No. 1 is the highest priced, No. 2, the next highest, etc.
[2] The letters indicate the comparative cost of application. No. *A* is the highest priced, No. *B*, the next, etc.

Various types of dyes for wool and their fastness characteristics

Price class [1]	Type of dye	Home washing	Laundry	Light	Gross dyeing	Cost of application [2]
1	Leuco vat	Excellent	Excellent	Very good	Excellent	*C*
2	Vat	Excellent	Excellent	Very good	Excellent	*B*
3	Chrome (chrome bottom, after chrome, metachrome, and alizarine).	Excellent	Excellent	Very good	Excellent	*A*
4	Neutral (dyeing acid)	Good	Fair	Good to fair	Poor	*G*
5	Direct (union)	Poor	Poor	Poor	Poor	*F*
6	Acid	Bad	Bad	Bad	Bad	*D*
7	Basic	Fair	Poor	Poor	Poor	*E*

[1] The numbers indicate the price class. No. 1 is the highest priced, No. 2 the next, etc.
[2] The letters indicate the comparative cost of application, No. *A* is the highest priced, No. *B*, the next, etc.

SECTION VII

FACTORY INSPECTION OF COTTON TEXTILES

35. General.—At all times the inspector should be observant and take note of any changes that may be occurring during the course of manufacture. There are three main points of check-up which should never be neglected. They are—

a. Raw stock grade.

b. Quality of gray goods.

c. Quality of finished goods.

However, the intermediate processes will bear watching, inasmuch as the detecting of defects in preliminary operations, and their consequent correction, will avoid the possibility of poor final results. There follows a résumé of the sequence of manufacture of cotton goods from a general standpoint. The steps are traced from the raw material to the finished fabric, indicating the most important danger points.

36. Cotton plant and varieties of cotton.—*a. Cotton plant.*—The cotton plant is a native of the tropics and attains a height of 2 to 4 feet. The seeds are contained in pods or bolls which are filled with a floss similar to that of the common milkweed. When the pod is ripe, it bursts, exposing the fluffy mass of fiber which is known as cotton.

b. Principal varieties.—(1) *Foreign cotton.*—(*a*) *Egyptian (Sakellaridis).*—This cotton is of a sea-island strain. It is fine, strong, soft, and silky, having an average staple length of 1½ inches. It has a light brownish cast, and in the trade is known as "Saks." It is used principally in the making of finer sewing threads and fabrics which require high tensile strength as well as regularity and fineness of fiber.

(*b*) *Indian cotton.*—This is a very poor cotton of the short staple variety ranging from five-eighths to seven-eighths of an inch. It is used by Japan and India mainly. It is generally used in the manufacture of coarse yarns for such fabrics as Osnaburgs.

(*c*) *China cotton.*—China cotton has a clean, white appearance, being of the short staple variety and averaging three-quarters of an inch in length. The fiber is of a rough and wiry variety. Its general use is for blankets and similar napped fabrics. It has excellent napping and fulling qualities.

(*d*) *Peruvian cotton.*—There are two kinds of Peruvian cotton, the smooth and the rough varieties. The rough variety has an average staple length of 1¼ inches. It has a creamy white color and is strong, wiry, harsh, and curly. Due to this harsh and curly quality, which most closely resembles the characteristics of wool, it is used for blending with wool in the making of merino yarns and French-spun knitting yarns.

(2) *American cotton.*—(*a*) *Sea-island type.*—This is the longest staple cotton grown. However, very little of it is produced. It has a fine, strong, soft, silky fiber, averaging a 1¾-inch staple.

(*b*) *Pima and SxP types* (*American-Egyptian*).—Pima is a Sakellaridis variety of cotton grown under irrigation conditions in Arizona. It has a light ecru color, closely resembling fine Egyptian cottons. The staple averages 1½ inches in length and is fine, strong, soft, and silky. This is used for fine sewing threads and fabrics.

SxP is a new type, crossing Pima and Sakellaridis.

(*c*) *Upland type.*—This is the most extensively raised variety of American cotton. It is very desirable, being soft and elastic, having an average staple length of seven-eighths of an inch.

It is mainly used for spinning coarse and medium counts of yarn used in the making of such fabrics as sheeting, drills, silesias, etc.

(*d*) *Gulf type.*—This is raised in the alluvial lowland soils of Mississippi, Arkansas, and Louisiana, and is known as "rivers," "peelers," and "benders." Of these, "peelers" is the most widely cultivated, being strong and lustrous and having an average staple length of 1⅛ inches. It is used for both carded and combed yarns, but most of it goes into the making of combed fabrics, such as broadcloth, uniform cloth, knitted underwear, etc.

NOTE.—Inspectors of textiles should familiarize themselves with the manual, "The Classification of Cotton," prepared by the Bureau of Agricultural Economics, Department of Agriculture. This manual gives a complete summary of cotton classification. It may be procured from the Superintendent of Documents, Washington, D. C.

c. Defects.—(1) When the pickers do not exercise proper care, the stem and leaves are picked along with the cotton, and a considerable quantity of dirt inevitably finds its way into the bags. The cotton

may be picked when it is damp, with the result that the teeth of the gin, instead of picking out the seeds and stems, will cut the matted fibers, producing a class of cotton known as "gin-cut."

(2) If cotton is left too long on the stem, it will be exposed to the detrimental effects of the weather. The coloring matter from the newly opened bolls or from the soil is washed into the floss by the rain, and, while such spots or stains may be bleached out by the sun, the lustrous bloom never returns. Frost will make permanent tinges or stains. For grading of cotton, see paragraph 21.

37. Preparatory processes of cotton fibers.—*a. Ginning.*—The object of ginning is to strip the fibers from the seed with as little injury as possible. There are two types of gin—one is the roller gin, the other, the Whitney saw-tooth gin. Practically 98 percent of all the cotton ginned is cleared on the Whitney gin. Sea island, Pima, and SxP cottons are roller ginned.

b. Inspection of cotton.—As the bales are designated for making up a mix, the inspector will pick representative samples from each bale, taking them to the cotton sampling room where he will staple and compare them for grade with the Government standards. Otherwise, they should be immediately forwarded to the depot laboratory for grading.

c. Cotton mixing.—The purpose of laying down numerous bales of different marks at the bale breaker for a mix is to obtain a regular quality of cotton over a long period of time, which will show through in the regularity and evenness of yarn produced. It is well for the inspector to make a cursory check-up for cotton grade at this point as well as in the warehouse.

d. Hopper bale breaker.—The hopper bale breaker is used to open out the compressed layers of cotton taken from the bales and to deliver them in an open-lofty condition. Care should be taken to see that the hopper is not more than three-quarters full, and that the cotton is distributed from side to side so as to allow for most efficient operation. Also the operative should throw thin layers from each bale into the machine, for if they are too thick the opening of the cotton will be very poor.

e. Opener.—The traveler belt or feeder from the bale breaker delivers the bunches of cotton to the opener, which repeats the operation of the bale breaker, reducing the large tufts into smaller tufts. By means of suction, the fluffy cotton is blown through air chutes to bins in the picker room, or else onto the automatic feeds of the breaker picker.

f. Pickers.—(1) There are the breaker pickers, intermediate pickers, and finisher pickers, which are either separate machines, or combined into one unit known as a "single process" picker.

(2) It is the function of the breaker picker to beat out the coarser impurities and deliver the cotton in the form of a roll of batting called a lap. The intermediate picker repeats the previous operation, taking four laps and delivering a single lap. The finisher picker repeats the same operation, and delivers a final single lap of fairly clean cotton, containing very little dirt and seed, but still fairly well filled with small particles of leaf. The inspector will check the weight of the laps for evenness.

g. Carding.—(1) This operation is for the purpose of removing foreign matter and short fiber and to open up the stock more thoroughly. Nearly all of the leaf, motes, neps, and very short fibers have been removed by the card wire action. The lap from the picker is fed into this machine which delivers the cotton in the sliver form, open and soft, the fibers lying in all directions.

(2) The main thing on which to check in this operation is that the main cylinder is not running too fast, as there will be a tendency to create neps and the cotton will not be cleaned out thouroughly enough.

38. Cotton yarn manufacture.—*a.* Cotton yarns comprise the following two general classes:

(1) Carded.
(2) Combed.

Cottons of the short-staple variety are generally made into carded yarns. Combed yarns are made from the longer staple cotton, such as sea-island, Egyptian, American, peelers, and alans.

b. In the event the yarn is to be combed, the following additional operations will be inserted before it goes to the drawing frame:

(1) *Lappers.*—These are two machines known as the sliver lapper machine and the ribbon lapper machine. About 20 card slivers are fed into the first machine, which is similar to a drawing frame except that it delivers in the form of a narrow lap which is wound on spools. Four of these laps are again combined on the ribbon lapper and form a single lap about 1 foot wide.

(2) *Combing.*—Eight rolls from the ribbon lapper are placed in separate heads, end to end, and each lap is fed through rollers between the teeth of the fine oscillating steel comb. Every back and forth motion is known as a nip, delivering about one-half inch of filmy sheet from which the short fibers have been combed out. The combed sheets are then once more condensed into a single sliver.

From this point on, combed and carded yarn go through the same operations. Up to 20 percent of short fibers are removed at the comb.

c. Drawing.—The object of this operation is to draw out the fibers, blending them more evenly and causing them to lay parallel to each other.

d. Roving operations.—The sliver must be reduced in size and given a certain amount of twist. There are four machines, the slubber, intermediate, fine, and jack frame. On each successive machine the sliver is being drawn down to a smaller size until it is about the diameter of a clothesline, but fairly soft. New equipment is radically reducing the number of drawing operations.

e. Spinning.—(1) Cotton yarn is spun either on the mule or the ring frame. Two ends of roving are still further reduced, and twist is inserted, delivering the final size of yarn required. The ring spun yarn is generally cheaper, due to lower cost of operation. However, it is not as elastic or as even as mule-spun yarn.

(2) When the frame or mule is being doffed, the inspector will select at random bobbins to check the size of the yarn, seeing that it does not vary to any great extent. He will also reel off approximately 240 yards to check the yarn for evenness.

f. Spooling, warping, slashing, and beaming.—From the bobbins the yarn to be used for the warp is wound onto spools or cones preparatory to being placed in a V-shaped creel from which they are run off evenly onto a warp beam. A number of these beams are combined, and the yarn is run through the slasher, which consists of a trough of sizing and a large steam-heated drum. From this drum the yarn is run under even tension onto the beam which will eventually be placed in the loom. The total ends on the beam should be checked. It should also be observed that the yarn is being wound under even tension on the beam; otherwise there will be the possibility of poor weaving developing.

g. Drawing-in and reeding.—The beam is now taken to the drawing-in room where the ends are drawn through heddles on the harnesses and then drawn through the reed to distribute them regularly and evenly. The beam is now ready to be placed in the loom.

39. Cotton gray goods manufacture.—*a. Weaving.*—The tension on the warp is very important in good weaving. Every so often the inspector should go through the weave room, testing the tension of the cloth as it is being woven and making certain that tight and loose places are not present in the warp. If feeler motions are not used, there will be a greater tendency for poor weaving results. A

check-up to see that the sand-roll is gripping properly and that the take-up is working correctly will help to prevent a tendency toward heavy and light places in filling direction.

b. Gray goods.—Cloth as it comes off the loom is known as gray goods. Prior to putting it through the finishing operations, the cloth is graded for weaving imperfections, stains, etc., into firsts and seconds. Representative samples of the gray goods to be used should be tested for weight and texture particularly.

40. Finishing of cotton fabrics.—*a.* There are many methods of finishing cotton fabrics, depending upon the kind of fabric desired. However, the general procedure is as follows:

(1) Brushing.
(2) Singeing.
(3) Scouring.
(4) Bleaching.
(5) Mercerizing.
(6) Dyeing.
(7) Drying.
(8) Calendering.
(9) Folding and inspecting.

b. Brushing.—The gray goods are first run through a machine which brushes up the fibers and loose ends.

c. Singeing.—In order to obtain a fairly smooth surface and impart a clear finish, the cloth is run at a high rate of speed through a series of gas flames, or over hot plates, singeing the surface fuzz without injuring the body of the cloth. If an undue amount of magnesium chloride is in the sizing used on the fabric, serious tendering will result due to the action of this compound after contact with the flame or heat of the singers.

d. Scouring.—There are two methods of scouring. One is done in the rope form and the other in the open width form. The rope form is used in the majority of finishing plants. The cloth is plaited down in large iron kiers and boiled in a caustic soda solution under pressure for the purpose of removing the waxes and sizing.

e. Bleaching.—Sodium hypochlorite is the most popular agent. A few plants use hydrogen peroxide. The active principle of this process is the releasing of nascent oxygen, which gives the cloth a clear white appearance as contrasted with the grayish or yellowish appearance of the gray goods.

f. Mercerizing.—This is a treatment of yarn or cloth under tension in a solution of caustic soda at 55° to 60° Tw. This is done to add luster to the surface of the fabric and aid the penetration of the dye.

g. Dyeing.—There are three basic forms of dyeing. They are raw stock, yarn, and piece dyeing. The majority of fabrics used by the Army are dyed in the piece.

h. Drying.—Cloth is run over a series of steam-heated cans, being held out to width as it is fed into the machine.

i. Calendering.—When a smooth handle or different degrees of gloss are required on the fabric, it is pressed between rollers. These rollers may be of metal or composition and are run either hot or cold. This operation of pressing the cloth between heavy rollers is known as calendering.

j. Folding.—After being dried, the cloth in rolled form is fed to the folding machine, which lays it back and forth in 1-yard folds. Frequently the tension on this machine loosens, resulting in the folds being less than a full yard in length. In checking over the finished cloth the inspector should be certain that each fold is a full yard in length.

k. Inspection—finished fabric.—As the cloth comes through the folding machine the inspector may get a fairly good idea of the general quality of the lot. It is well to pick pieces at random as they are being placed on the inspection tables and to give them a hand inspection, checking for dyeing defects and weaving defects.

l. Dyeing defects.—Check the shade of the fabric against the standard for color, watching for stains, streakiness, and side-to-side and end-to-end shading in the piece. Make certain that each lot is carefully shaded for light and dark pieces.

41. Weaving defects.—Make sure that all major defects are cut out and that the minor defects are strung and proper deduction made from the gross yardage of the piece.

SECTION VIII

FACTORY INSPECTION OF WOOLEN TEXTILES

42. General.—It is not possible to confine to this manual all the technical information required by an inspector. However, the following are some of the most important operations in the manufacture of woolen textiles, and the inspector should carefully check the result of each, as it is only by each operation's being performed in a satisfactory manner that a suitable piece of cloth can be made.

43. Wool sorting.—This is the first operation with which an inspector assigned to factory inspection will come in contact, and, like all other operations, unless it is being performed in an efficient manner, cannot be expected to produce a good fabric. If fleece wool is being used, the inspector must see that the fleece is properly skirted off and loam and soil removed, and then that the balance is sorted in such a manner as to give the grade and character desired in the main sort.

44. Wool scouring.—After sorting, the next process in the manufacture of woolen textiles is the scouring of the grease wool. Wool, as it comes from the sheep's back, contains from 25 to 80 percent of greasy suint, dirt, and other foreign matter that must be removed before the wool can be used. Scouring must be carefully observed by the inspector to insure that the wool is not damaged in the process. The most common damage during the scouring process is from the use of caustic soap (which will leave a harsh wool), excessive heat (which weakens the fiber), and excessive agitation of the wool during the scouring process (which causes felting and subsequent damage to the wool in carding). Grease wool is cleansed by soap and alkaline solutions and by the solvent process; partial degreasing is accomplished by defrosting.

45. Wool dyeing.—A great number of variables must be exactly duplicated in order for a dyer to secure uniform results on succeeding batches. An inspector should be familiar with the problems of the dyer and see that he does everything possible to obtain uniform results.

He must see that the specification type of dyes is being used and that the wool is not being damaged in the dye house.

46. Blending and mixing.—An inspector should make a record of the various dye lots and amounts of each used in producing the contractor's approved sample, see that subsequent lots are blended in the same proportion, and that the mixing is true. Laying down a mix, the feeding of this mix to the picker, and the number of times it is run through the picker must be uniform for all lots, or the yarn produced therefrom will not be uniform.

47. Carding.—The strength of a fabric depends greatly upon the strength of the yarn from which it is made, and the strength of the yarn is affected very much by the efficiency of the carding operation. An inspector must watch the feeding of the cards to see that it is uniform and the condition of the cards to see that they are operating properly. Another very important point is to see that card strippings and such other waste prohibited by the specifications are not being made. The inspector should check the weight of roving coming off the cards.

48. Spinning.—The spinning operations require very little observation by the inspector. The main points to be watched are the evenness, cleanliness, strength, and size of the finished yarn.

49. Twisting, winding, and spooling.—These operations are of little interest to the inspector and require little or none of his time.

50. Warping, beaming, drawing-in, and reeding.—These operations should be observed by the inspector, and he should check the number of ends in the warp to be sure that there will be the proper number in the finished cloth. If the drawing-in and reeding are not correct, it will show up as soon as the weaving is started.

51. Weaving.—The inspector should observe the tension and make sure that it is even. He should observe what stop motions are being used, and whether or not they are working properly. He should check the weave to see that it is correct, and the number of picks per inch to see that they are running uniform. Another very important point that the inspector must watch is the filling yarn being used. He must see that different shades are not being mixed in such manner as to cause shade bars in the cloth.

52. Burling and Mending.—Mending of defects in the cloth as it comes from the loom is always necessary, and, if properly done, the result will be as good as if the cloth had been perfect when taken from the loom. Knots should be pulled through to the back of the fabric, all missing threads should be replaced, and the cloth made as perfect as possible before proceeding with other finishing operations.

53. Finishing.—Seventy-five percent of an inspector's time should be spent in the finishing room, as there is no other place in a woolen mill where so much trouble occurs. The finishing operations on a woolen fabric may consist of any or all of the following operations, and each one is a potential source of trouble:

Burling (see par. 52).
Mending (see par. 52).
Scouring.
Fulling.
Washing.
Carbonizing.
Dusting.
Neutralizing.
Napping.
Tentering.
Shearing.
Pressing.
Inspecting.

54. Scouring.—The cloth as it comes from the loom contains a certain amount of oil and dirt which must be washed out before fulling. This operation requires very little of the inspector's attention. The main point is to see that the type of soap used is not injurious to the fabric.

55. Fulling.—There is probably no more important operation in the finishing of a piece of wool cloth. Here the cloth is changed from a loosely woven fabric, resembling a piece of burlap, into a more or less compact fabric with the desired texture. This is accomplished by subjecting the fabric to the kneading action of the fulling mill in the presence of soap. The starter must see that each piece is treated as uniformly as possible, as it must be remembered that the longer a piece is in the mill the more color will be lost, and shade trouble will result. It is important to know what fulling compound is being used, and it is well for the inspector to submit a sample to the laboratory for test, unless he is sure what is being used. The heat generated by the friction of the cloth in the mill must be controlled. This is usually done by opening or closing the doors of the fulling mill. The proper fulling temperature should be between 90° and 110° F.

56. Washing.—After fulling, the cloth must be washed free of the soap used in that operation, and the inspector must see that this operation is performed in a satisfactory manner and that the concentration of such chemicals as are used is controlled.

57. Carbonizing.—Carbonizing consists of treating the fabric with sulfuric acid or aluminum chloride, then passing the cloth through a dryer in order to bake such vegetable matter as there may be present in the cloth.

58. Dusting.—After the cloth is removed from the dryer, it is put into a fulling mill and run through. This process will dust out all the carbonized vegetable matter.

59. Neutralizing.—After being dusted, the piece is then neutralized. The dyes used in dyeing olive drab fabric are made from a mixture of a number of different colors of dyes. Each one of these different colors is likely to change when subjected to the action of acids or alkalies. Therefore, when the piece has been treated with acid it changes color, but when this acid is neutralized, the color changes back to the original shade. From this it is easy to see that unless all of the carbonizing operations are positively controlled, the cloth will be of different shades. An inspector assigned to a mill must familiarize himself with this process and watch the operation very carefully.

60. Napping.—Napping should be held to the minimum necessary to give the desired finish and should never be done in such a strenuous manner as to injure the fabric. The inspector should observe this operation and see that the napping is uniform throughout the fabric.

61. Tentering.—The principal point to watch in this operation is to see that the cloth is so placed on the tenter pins that it will not be damaged, and that no cloth is allowed to remain in the dryer long enough to injure it.

62. Shearing.—The inspector must watch the shearing to see that the pieces are being evenly sheared and that the shear flocks are being properly removed. A great many mills have installed sewing machines that will seam the cloth in such a manner that it is not necessary to lift the shear blades in order to pass over a seam. In those mills that do not have this equipment the shear blades must be lifted in order to keep from cutting the cloth when a seam passes under the blade. This results in the improper shearing of a few inches of cloth on the end of each piece. This end will be cut off before the piece is shipped.

63. Pressing.—In the operation of pressing, as well as in a great many other operations, the inspector's principal care is to see that the cloth is not unduly stretched.

64. Inspecting.—The final mill inspection of woolen cloth is always done by running the cloth over a finish perch where the mill

inspector removes surface specks, such as burrs, and observes the piece for defects. If defects are found, a string is tied into the selvage and proper allowance is made for the defect. The cloth is usually measured at this time and put up in its final shipping form.

65. Shading pieces before shipment.—An inspector should always compare a sample swatch from each piece of finished cloth with the standard sample and advise the contractor to ship only those pieces that appear to be satisfactory for shade and finish.

66. Other operations.—While the foregoing covers the principal operations in the finishing of woolen cloth, there are numerous other operations, all of which must be carefully controlled by the contractor and checked by the inspector in order to turn out a satisfactory piece of cloth.

SECTION IX

FACTORY INSPECTION OF WORSTED FABRICS

67. General difference between woolen and worsted fabrics.—*a.* The essential difference between an all woolen and all worsted fabric is the manner of processing the raw material. The wool used in a woolen fabric passes through two major mechanical processes while being made into yarn—namely, carding and spinning. In making worsted yarn, the wool is subjected to the following processes:

(1) Carding.
(2) Gilling.
(3) Combing.
(4) Regilling.
(5) Drawing.
(6) Spinning.

The combing process removes the short wool fibers and lays the long fibers parallel. For this reason adulteration with reworked wool cannot be carried on successfully in worsted manufacture. The subsequent operations likewise parallel the fibers preparatory to spinning. Since the invention of the "French", or mule spun, as distinguished from the "Bradford", or frame spun process, the line between combing and clothing wool is not so sharply drawn. Shorter fibers can be used in producing worsted yarn with the French system than with the Bradford system. The noil or short fiber removal on the French

system can be adjusted to as low as 2 percent, while on the Bradford system the minimum production of noils approximates 7½ percent.

b. The drawing operation, which follows combing, is a series of doublings and drawing or attenuating, which thoroughly blends, mixes and parallels the fibers in the resultant yarn. In French drawing, the Army 18-ounce serge yarn receives 115,200 doublings.

c. For worsted manufacture, the points to be observed in the sorting and scouring of the wool are identical with those given in paragraphs 43 and 44. It is to be observed, however, that a better selection of the raw wool is made for worsted than for woolen manufacture, both as to length of staple and freedom from burrs, straw, or other foreign vegetable matter, as worsted fabrics ordinarily do not receive a carbonizing treatment, all foreign vegetable matter being removed by mechanical means.

d. Unlike woolen manufacture, the wool is carded, gilled, and combed before dyeing, all operations paralleling the fibers. In this form, known as top, the fibers are dyed (top dyeing). The next process in the manufacture of the yarn is recombing, drawing, and spinning. These operations, which remove the short fibers and further parallel the longer ones, require very little observation by the inspector, evenness and strength being the principal points to be checked.

e. The twisting, winding, warping, beaming, drawing-in, reading, weaving, burling, and mending operations should be observed as given in paragraphs 49 to 53. The same amount of care is required to finish a worsted as to finish a woolen fabric, the principal operations of which are as follows:

Burling.
Mending.
Scouring.
Fulling.
Washing.
Crabbing.
Napping.
Tentering.
Shearing.
Decating.
Pressing.
Inspecting.

All of the observations made in paragraphs 49 to 52, where applicable, should be made by the inspector on both woolen and worsted fabrics.

SECTION X

FACTORY INSPECTION OF KNITTED MATERIALS

68. Yarn preparation.—The yarn preparation and spinning of the yarn used in knitted materials are the same as those given in sections VII, VIII, and IX, for cotton, woolen, and worsted fabrics, with the exception of a lesser amount of twist per inch used in the yarns of knitted fabrics.

69. Inspection of socks and underwear.—The specifications for the lightweight woolen socks, undershirts, and drawers, as used by the Army, require that the finished garments should contain 50 percent wool and 50 percent cotton. Cognizance should be taken of the fact that this is on a bone dry basis, and, ordinarily, an amount of wood greater than 50 percent is necessary, owing to the ability of the wool fiber to retain up to 18 percent of moisture, while the cotton can retain approximately 11 percent of moisture. The inspector should carefully check the moisture content of the various lots previous to blending, in order to insure receipt of a finished item containing not less than 50 percent wool.

70. Inspection of mufflers, sweaters, and woolen gloves.—Mufflers, sweaters, woolen gloves, and inserts for leather gloves are "all wool" items. From a factory inspection standpoint, it is necessary for the inspector to carefully check at all times the grade of wool specified, the texture, wales and courses, and the finished weight of each item. On gloves, where a large amount of hand finishing is necessary, care must be taken to insure that the thumb and fingers are securely sewn.

71. Inspection of knitted fabrics.—Single knitted fabrics are constructed by a series of loops of a single thread. Woven fabrics are composed of two systems of threads interlacing at right angles. For this reason, it is important for the inspector on all knitted items of clothing to make sure that all holes in the fabric are carefully and expertly mended in order to avoid "runs" in the garment.

72. Final inspection.—In the manufacture of socks (cotton, cotton and wool—light-weight, and cotton and wool—heavy-weight) care must be taken to insure that the socks are well rinsed before boarding, in order to avoid rancidity due to soap or finishing oils used in the

scouring process. Prohibition of the use of weighting materials is likewise a function of the inspector. It is equally important for the inspector to check the boarding operation, insuring that the correct knitted size is boarded on the corresponding sized forms. For example, a sock knitted to size 10 and "boarded up" to size 12 will return to its original knitted size after the first laundering. Temperature control in boarding must be carefully supervised in order that the socks will not be damaged by excessive heat.

SECTION XI

FINAL INSPECTION AND ACCEPTANCE

73. Purpose and scope.—*a. Purpose.*—(1) Briefly, final inspection of materials is made for the purpose of insuring that they conform in all respects to the contract requirements, including the proper packing and marking for shipment.

(2) Final inspection may be made at the point of origin or at destination, such as a receiving depot or plant at which they may be used in the manufacture of some commodity. The determination of the final inspection point is usually controlled and designated by the purchasing office.

b. Extent.—The extent of the final inspection to be given finished materials must be determined by the purchasing office. It should be sufficient to guarantee the acceptance of materials meeting contract requirements insofar as time and inspection facilities will permit, and may be further qualified by the extent of the inspection during manufacture. In general, those materials, otherwise known to be satisfactory ,which are impaired for serviceability and appearance by manufacturing defects, apparent only in the finished state, should be inspected to the fullest extent. Such materials include those used for outer clothing, protective clothing, blankets, bobbinet, etc. Those materials which are not affected by minor manufacturing defects may be inspected in their completed form to a much lesser extent. Thus, such materials as linings, duck, work clothing materials, etc., may be given only an inspection of a small percentage of the production involved.

74. At point of origin.—*a. General.*—(1) The chief reasons for providing for final inspection and acceptance at a contractor's plant are—

(*a*) By factory inspection, it is possible to avoid the loss of time that would result if materials, which may be urgently required, were shipped to a distant point and there found to be unsatisfactory, necessitating a lapse of time for replacement.

(*b*) To expedite the delivery of materials to the using point by eliminating an intermediate stop for inspection.

(*c*) To promote production by rejecting unsatisfactory materials at the contractor's plant, which may be reprocessed and made acceptable.

(2) In inspection of this type, the duties of the inspector include not only the inspection of the raw materials and processes of manufacture, but also of the finished materials and their packing and marking for shipment. The inspector must have authority to reject finished materials which do not meet contract requirements. Failure to meet contract requirements includes such delinquencies as unsatisfactory raw stock, improper methods of manufacture, failure to meet finished requirements, and shipments not properly packed and marked.

(3) When the contract or purchase order provides for delivery and acceptance f. o. b. cars, site of the contractor's plant, the material when accepted by the inspector becomes the property of the Government upon delivery to and acceptance by the carrier. Details as to the method of accomplishment of receiving reports and bills of lading should be furnished inspectors.

(4) When the contract or purchase order provides for delivery and acceptance f. o. b. a contracting depot, or other station, the materials which are found to meet contract requirements may be accepted by the inspector at the factory insofar as quality or grade is concerned, but they do not become the property of the Government until delivered to the destination provided in the contract, and are there finally inspected. In this case the inspector certifies only to the acceptability of the materials. The delivery of the materials is the responsibility of the contractor.

(5) In no case should materials rejected by the inspector be shipped.

b. Method of inspection.—(1) In most instances, final inspection at the contractor's plant must be made coincident with that of the contractor. Physical inspection so made not only saves time, but serves to check the quality of the contractor's inspection. The inspector who is making final inspection at a factory should arrange his work so as to assist the contractor in the satisfactory completion of his contract and not retard production except for good and sufficient

cause where it may be necessary to reject part of the finished materials. Inspectors should not interfere with the duties of the subordinate help of the factory in their work. If finished materials do not meet contract requirements, such information must be reported at once to the proper representative of the contractor, and, if the difficulty involved is serious, report in detail should be made at once to the contracting office.

Rejected materials should be kept under close observation to insure against their shipment. If there is reason to believe that rejected materials have been shipped, detailed information should be given the contracting office immediately in order that further inspection may be made at the place of delivery.

The contractor's inspection includes the marking of defects in the finished material, as, for example, by placing markers in the selvage of a fabric, and the quality of his final inspection is judged by his properly marking defects and making such deductions in yardage as the contract requires.

It should also be noted whether an effort is being made by the contractor to eliminate in manufacture defects found in the final inspection of finished materials.

(2) In addition to the physical inspection of such quantities of finished materials as may be directed, compliance with contract requirements must be verified by the frequent use of test methods on samples, their extent to be determined by time and the availability of testing facilities. The following requirements may be readily checked in most instances:

Texture.
Tensile strength.
Weight.
Size content.
Shade.
Shrinkage.
Width.

For the testing of color fastness, determination of dyestuff used, and any special tests, frequent samples of finished materials should be forwarded to a designated point where more complete testing facilities are available. Also, in case the inspector is not satisfied with the results of his own tests, samples should be forwarded with specific comment as to what tests are desired and observations as to tests already made.

(3) In event that materials have been manufactured prior to the inspector's arrival at the plant, inspection should follow the procedure

outlined above, where practicable, but in all cases a sufficient portion of the finished materials should be selected at random and inspected to insure beyond a doubt that contract requirements have been complied with.

c. Types of defects.—The types of defects are listed in section XII and are intended to serve as a guide in the inspection of finished materials, whether made at the contractor's plant or at destination. These terms are of common usage and have a generally accepted meaning with reference to textile materials. However, there are many other terms applicable to defects in finished materials having various meanings in different localities. This list gives a satisfactory description of the most common defects to be looked for in the inspection of finished materials.

75. At destination.—*a. General.*—(1) Final inspection and acceptance at destination may be made due to the following conditions:

(*a*) Purchase of materials already manufactured.

(*b*) Manufacturing processes not continuous, making final inspection at last stage of manufacture not especially desirable.

(*c*) Final inspection not practicable at place of manufacture.

(*d*) Materials to be placed in use or repacked at destination.

(2) When materials are inspected at destination, the inspection consists of two phases:

(*a*) *Reports from inspectors during manufacture.*—These reports serve as a guide to inspection by advice relative to defects observed during manufacture, shipment of defective materials, use of nonspecification raw stock or improper manufacturing processes.

(*b*) *Physical inspection of materials.*—The extent of the inspection of materials received may be unlimited as to available facilities, but as previously stated should be determined by the purchasing agency.

b. Method of inspection.—(1) Facilities must be available for the proper handling of materials for inspection. These facilities include such equipment as cloth perches for the visual inspection and measurement of materials, tables for examination of materials not received in a form suitable for inspection on perches, provision for "thru-lighting", a suitable room for shading purposes, tensile strength testing machines, measures for width, provision for trucking, and unpacking and repacking of materials.

(2) The following information will be found useful in planning the inspection of textiles:

(*a*) When inexperienced inspectors are employed, they should be provided with samples of type defects for a guide in the performance of their inspection.

(*b*) The most rapid and thorough inspection of fabrics is made by running them over an inspection perch. This method also gives an opportunity for accurate measurement and "thru-lighting." Two inspectors operate a perch for the examination of woolen and worsted fabrics, one examining the face of the material and one the back. Defects may be readily marked by running a string through the selvage opposite each defect. Production on woolens and worsteds should average 3,500 yards per perch, for an 8-hour day. Cotton fabrics may be examined on a perch by one inspector with an average production of 6,000 yards per 8-hour day.

(3) Samples for required tests must be made available immediately upon receipt of shipments and inspection of shipments withheld until such tests are completed, particularly where factory inspection reports have indicated a failure to meet contract requirements.

(4) Shading of fabrics may be done at the inspection perches or tables, provided they are located in a good light. It may be necessary to cut swatches from each piece of material or representative pieces and take them to a suitable location for comparison with a standard or accepted shade sample.

SECTION XII

DEFECTS FOUND IN FABRICS

76. Defects found in fabrics.—*a. Cotton.*

Cotton
Unsatisfactory combing.
Not thoroughly cleaned.
Motes.
Neps.

Yarn
Coarse ends.
Coarse picks.
Fine ends.
Fine picks.
Warp slubs.
Filling slubs.
Wrong twist ends.
Wrong twist picks.
Hard ends.
Hard picks.
Uneven filling yarn.
Uneven warp yarn.

Miscellaneous
Under in filling strength.
Under in warp strength.
Under in filling texture.
Under in warp texture.
Damaged places.
Holes.
Two-part piece.
Short yardage.
Short length.
Short folds.
Underweight.
Overweight.

Color
Off shade.
Shaded side to side.
Shaded end to end.
Shaded side to center.
Shaded in the piece.
Uneven dyeing.
Shade bars.
Color tests unsatisfactory.
Cloudy finish.
Dye specks.
Streaks.
Stains.

Finishing
Finished on wrong side.
Excessive shrinkage.
Narrow width.
Unsatisfactory finish (state reason).
Not clean.
Rancid odor.
Specks.
Slack selvage.
Torn tenter holes.
Folded selvage.
Torn selvage.
Sanforizing marks.
Cockles.

Weaving
Wrong weave.
Uneven weaving.
Mispicks.
Change of filling.
Floats.
Ends out.
Filling draw back.
Harness skips.
Knots.
Kinky filling.
Reed marks.
Smash.
Wrong draw.
Broken picks.
Broken ends.
Slack picks.
Slack ends.
Tight ends.
Imperfect burling.
Start-up:
Heavy.
Light.
Uneven tension.

b. Woolen and worsted.

Color
Cloudy.
Color test not satisfactory.
Off shade.
Shade bars.
Shaded end to end.
Shaded side to center.
Shaded side to side.

Yarn
Coarse end.
Coarse pick.
Filling slubs.
Warp slubs.
Yarn contains sisal.

Miscellaneous
Short yardage.
Short length.
Two parts (show both measurements).
Damaged places.
Holes.
Under in filling strength.
Under in warp strength.
Under in filling texture.

Weaving
Broken picks.
Ends out.
Filling draw back.
Floats.
Harness skips.
Knots.
Kinky filling.
Mispicks.
Reed marks.
Smash.
Tight ends.
Wrong draw.
Light places.
Heavy places.

Finishing
Cockles.
Excessive shrinkage.
Finished wrong side.
Narrow width.
Wide width.
Not clean.
Sheared too close.
Not sheared sufficiently.
Unsatisfactory finish.
Shear cuts.
Shear rubs.
Stains.
Streaks.
Slack selvage.
Rancid odor.
Shives.
Specks.
Uneven felting (for use in connection with felt).
Uneven fulling (for use in connection with cloth).
Excessive crepeing.
Filling not straight.

c. Blankets.

Wool

Color blending unsatisfactory.
Pilled wool.
Specky.
Color tests unsatisfactory:
  Weather.
  Laundering.
  Crocking.

Color

Off shade.
Cloudy.
Shade bars.

Miscellaneous

Not clean.
Uneven yarn.
Slubs.
Narrow width.
Short length.
Cut selvage.
Tenter pin cuts.
Holes.
Insignia:
  Double.
  Illegible.
  Not centered.
  Solution too strong.
Nonspecification binding thread.
Stains.
Underweight.
Under warp strength.
Under filling strength.
No contract label.

Weaving

Nonspecification weave.
Uneven weaving.
Harness skip.
Picks:
  Broken.
  Double.
  Heavy.
  Missing.
Warp ends:
  Broken.
  Missing.
Wrong draw.
Fine yarn bars.
Shade bars.
Under warp count.
Under filling count.

Finish

Insufficient nap.
Overnapped.
Tuck napping unsatisfactory.
Nonspecification binding stitch type.
Binding stitches under 14 per inch.
Loose tension binding stitches.
Binding ends unraveled.
Unsatisfactory mending.

d. Knitted fabrics.

Material

Drop stitches.
Ends out.
Holes.
Mends.
Needle streak.
Off shade.
Press off.
Shives.
Tuck stitches.
Uneven yarn.
Unsatisfactory knitting.
Under in courses.
Under in wales.
Yarn slubs.

e. Bobbinet.

Warp slubs.
Filling slubs.
Broken warp ends.
Off color.
Streaks.
Stains.
Two pieces (show both measurements).
Under yardage.
Narrow width.
Holes.
Insufficient sizing.
Contract excess.
Contract wrong number.
Under filling strength.
Under warp count.
Under filling count.
Under warp strength.
Under bobbin thread strength.
Coarse ends.
Coarse bobbin yarn.
Not clean.
Damaged places.

SECTION XIII

DRAWING AND SUBMITTING SAMPLES

77. General.—Except when the contract provides that the materials shall be furnished by the United States, the inspector will send samples of raw materials to the contracting depot frequently enough to assure that materials on the entire contract are uniform and of proper quality. On contracts for cloth, garments and other textiles, and supplies involving large quantities of similar materials, samples of raw materials will be submitted at least once each week unless otherwise directed by contracting depot. When new supplies are received or used, samples should be immediately submitted to the depot. Samples should not be sent to any place except the contracting depot.

78. Unusual situations.—Should any unusual situation arise of which the inspector thinks the depot should be informed regarding these raw materials, such as the lack of uniformity in the material used although all from one purchased lot, samples should be submitted at once, accompanied by a report as to the reason therefor.

79. Selection of samples.—*a.* Samples of finished articles will be selected at random from current production and submitted to the depot weekly, unless some particular question arises which may require more frequent submission.

b. Samples must be taken by the inspector from material in the factory for use on the contract. Salesmen's samples on approval submitted to the contractor should not be submitted.

80. Labeling of samples.—*a.* In submitting samples, the inspector should indicate the following information on the wrapper containing the raw material or on a tag securely attached to a garment or other unit submitted:

(1) Contract number and article.

(2) Contractor's name, name of subcontractor, if any, and name and location of plant.

(3) Articles being manufactured and number of sample. (Number samples from one (1) upward in numerical sequence, in a continuous

series of numbers during the entire duration of a contract, regardless of whether the item is of a different object than the preceding number.)

(4) Type of material (if raw material, for what it is used or what it is supposed to represent, and to be identified by lot number, bale number, or similar designation).

(5) Date on which sample was drawn and the point in the plant at which drawn.

(6) Quantity in the lot, or batch, of which the samples are representative.

(7) Name of inspector.

b. Inspectors must not become careless in the numbering and identifying of samples forwarded. In order to produce uniformity, samples of *raw materials* will be either wrapped in individual packages or enclosed in separate envelopes.

c. Sample of information on tag for sample:

Contract No. _____ Article _____
Contractor _____ Lot or bale No. _____
Mill _____ Date _____
Location of mill _____
Sample of _____ Sample No. _____
Quantity in lot or batch _____ Dept. _____
_____
Inspector
Number each sample submitted consecutively regardless of description of sample (start with No. 1).
Remarks: _____

d. It is not the intention to restrict the responsibilities of an inspector by passing on samples which he may forward. The only reason for expressing an opinion upon such samples is to produce uniformity among the various inspectors assigned to different mills manufacturing the same article. Inspectors should advise contractors to await the approval of raw material samples before beginning processing.

e. The inspector, under all contracts involving raw materials, should retain for reference and comparison thereafter, a portion of each sample forwarded to the depot.

81. Size of samples.—All samples must be of sufficient size to make an intelligent laboratory test. The inspector is to study the specifications with a view to determining the number of tests necessary, and, therefore, the size of the sample to be forwarded. Necessary specification tests should be made at the plant as far as practicable. This applies particularly to garments.

82. Disposition of samples rejected by contracting depot.—When the inspector receives notice of the unacceptability of either materials or garments as represented by the samples submitted by him to the depot, he will include in his next report following the receipt of this information a direct statement as to whether the materials of which his samples were representative have actually been used in the manufacture of the article which he is inspecting, and will indicate the disposition made of them by the contractor, that is whether rejected, withheld, or returned to seller.

83. Reporting goods manufactured from rejected samples.—If the materials have been used and if goods manufactured from them have been shipped, he will also report this fact, giving the details of the shipment when known, that is, the date when it went forward, the depot of destination, and the case numbers involved.

84. Time necessary for forwarding, testing samples, and the expediting thereof.—The inspector must realize that he is not the only person submitting samples to the depot for testing and consideration. Therefore a certain amount of time must be allowed for the transmission of the samples to the depot, for the testing thereof, and report of findings of the depot. In the event the material represented by the sample taken by the inspector is urgently needed in the manufacture, the inspector may consult with the contractor if a telegraphic reply is desired. In the event a telegraphic reply is agreed to by the contractor, the results of the tests of the samples will be sent to the contractor "Commercial collect." The inspector should mention this in his report.

SECTION XIV

REPORTS OF INSPECTORS TO CONTRACTING DEPOTS

85. General.—The reports used by inspectors will be covered by special instructions issued by the contracting depot.

86. Letter report.—Immediately after arrival at the plant, the inspector will send a report stating the date and exact time of departure from permanent station and arrival at temporary station.

87. Report of factory inspection.—This report is to be made in

triplicate twice each week, Wednesdays and Saturdays, unless the inspector is instructed otherwise. Copies are to be distributed as follows: One copy to be sent to the commanding officer of the purchasing depot, marked "Attention Inspection"; one copy to be given to the contractor; and one copy to be retained by the inspector. All three copies must be signed.

88. Confidential report.—This sheet is to be executed in duplicate, one copy to be retained by the inspector and one copy to be forwarded to the purchasing depot with "Report of Factory Inspection" and pinned thereto.

89. Exceptional reports.—In cases where, due to the character and limited quantity of supplies involved and the brief time required for the inspection, the use of the semiweekly report and confidential report mentioned in the preceding paragraphs is not desired, these forms may be omitted upon authority of the contracting depot and report be submitted in such form as that office may require.

90. Report of completion contract.—A short time prior to the completion of work on which engaged at a temporary station, the inspector should inform the contracting office the expected date of completion so that, if desired, an assignment elsewhere may be given to him.

SECTION XV

PRODUCTION DELAY

91. Information to be assembled for reporting production delay.—In order that the contracting depot may be adequately informed regarding alleged delays sustained by contractors due to strikes, storms, epidemics, etc., pertinent information with respect thereto will be included in confidential reports.

a. The cause and extent of any delay, regardless of how unimportant it may seem at the time, will be reported.

b. Should conditions arise which may lead to delays by contractors in deliveries at a future date, the salient facts relative thereto should be reported at once.

c. In event of a strike's occurring, this report should include:

(1) Date strike began.
(2) Cause of strike.
(3) Number of employees working before the strike.
(4) Number working each day during the strike.
(5) Number out each day because of the strike.
(6) Date strike terminated.

d. In the case of loss of production due to an epidemic, this report should include:

(1) Nature of epidemic.
(2) Number of employees working before epidemic.
(3) Number working each day during epidemic.
(4) Number absent each day because of epidemic.
(5) Date full production was resumed.

e. Information similar to that in *c* and *d* above should be reported in case of delay due to fire, storms, flood, and other unusual occurrences.

f. The inspector will in all cases state once a week, on the confidential sheet of his report the approximate number of employees engaged on Government contract and the number engaged on commercial work, if readily obtainable; otherwise, state briefly the ratio of plant equipment allocated to Government and commercial work.

g. In event of delayed production due to any reason other than stated above, the inspector will report the nature and extent of the delay, the specific causes (such as failure to receive cloth or material from commercial sources), and any other pertinent information. He will report when the deficiency is overcome and full production resumed.

Section XVI

RECEIVING REPORTS

92. General.—When acceptance is at point of production, inspectors will be required to submit receiving reports and bills of lading in accordance with Army Regulations, and such specific instructions as may be issued. For a brief survey of the general procedure the following, together with information contained in section XVII, is given.

93. Use.—Receiving Report (W. D., Q. M. C. Form No. 430), original and at least five copies, is required from inspectors who are making preliminary inspection for quality at place of manufacture, although final acceptance is f. o. b. the receiving depot. The signed inspection certificate on back of the receiving report is a certification from the inspector that the quality of materials he lists on the

face thereof conforms to all requirements of specifications and the contract.

94. Completion of receiving reports with acceptance at Destination.—*a.* Such receiving reports, however, are only partially filled out; that is, no date is inserted after the word "received" in the upper left-hand corner. This space is left blank in order that the receiving depot may insert the date on which the shipment is received at destination. The other spaces will be filled in.

b. Headings of the form to be filled in as follows:

(1) Under "Number Packages" the total number of containers and number of each container.

(2) Under "Quantity" the total quantity in the shipment.

(3) Under "Stock No." the stock number of the article.

(4) Under "Article" description of the material in the same terms as used in the contract or purchase order.

(5) Under "Unit" the same unit used in the contract or purchase order.

(6) Under "Unit cost" the price of each unit.

c. When shipments are made to more than one point of destination, a separate series of shipping numbers will be made for each delivery point. Each series will begin with No. 1 and will continue in numerical sequence. For example, the first shipment from the factory goes to Chicago Quartermaster Depot; this is "Shipment No. 1." The second shipment goes to New York. It is in reality the second shipment from the factory, but the first to New York; therefore, it is "Shipment No. 1" on the allotment for New York.

d. On the reverse of the receiving report no rejections will be shown. That space is for use by the receiving depot.

e. The inspection certificate, on the reverse of the receiving report, will be signed by the inspector, crossing out the words "and accepted." See that each sheet is signed prior to mailing.

95. Distribution of receiving reports with acceptance at destination.—The original and three copies of the receiving report will be mailed at once to the receiving depot to which the shipment was made. The fourth copy will be mailed to the contracting office marked "Attention Inspection." The fifth copy will be retained by the inspector.

96. Completion and distribution of receiving reports with final acceptance at point of manufacture.—*a.* When final inspection and acceptance is f. o. b. factory or place of manufacture, the receiving report must be completely filled out. The receiving date (upper left-hand corner of the report) will be the date on which the

material is accepted and shipped. On such shipments, the number of the Government bill of lading on which the shipment is made will be shown in the space after "Govt. B/L."

b. On shipments accepted at origin, the original and three copies of the receiving report will be mailed to the contracting office marked "Attention Inspection."

SECTION XVII

BILLS OF LADING AND CONTRACTOR'S INVOICES

97. Use of bills of lading.—Government bills of lading are furnished inspectors only in cases in which final inspection and acceptance is f. o. b. cars, city of contractor's plant, so that the supplies become Government property when delivered to and receipted for by the carrier, unless instructions are otherwise. In such cases, the words, "and accepted" in the inspection certificate on the receiving report will not be deleted, and the Government bill of lading number and seal numbers will be shown on the receiving report.

98. Request of bills of lading from contracting depots.—If the materials are to be shipped by the Government to the contractor, or if supplies are to be shipped from the factory on Government bills of lading, the inspector when requesting bills of lading will inform the contracting office whether there is a railroad siding at the contractor's plant, and if so, on what railroad. If there is no siding at the factory, he will advise what railroads are in the city, and which one is most accessible to the factory when loading, if there is much difference in the distance.

99. Loading of accepted material on carrier.—Unless otherwise specified, the packing and draying of supplies to the carrier are the function, obligation, and responsibility of the contractor, both when the f. o. b. point specified in the contract is "f. o. b. cars, city of contractor's plant," and when it is f. o. b. destination. This includes drayage from the contractor's plant to siding or freight station, and also all expense of loading cars. If procurement is f. o. b. cars, city of contractor's plant, this work is subject to the inspection and approval of the inspector, and it is his duty to observe packing

of supplies to the extent of seeing that requirements of the contract and specifications with regard to packing and marking are fully met. Special precaution will be taken by inspectors in the case of glassware, chinaware, and other fragile supplies, particularly when shipment is on Government bill of lading, to see that they are packed in the best possible manner to insure delivery at destination in undamaged condition.

100. Ordering of cars from railroad.—*a.* When supplies are to be shipped on a Government bill of lading, the inspector will not permit the contractor to load cars or turn the supplies over to the railroad company until he has received from the contracting office a bill of lading and instructions for shipment. Disregard of these specific instructions may cause the accrual of demurrage charges which cannot be assumed by the Government. The inside of every car must be inspected prior to loading to see that roof and walls do not leak, that car is sufficiently clean to accommodate the commodity to be loaded therein, and that no protruding nails and other conditions exist that would damage the contents of the shipment.

b. Each set of Government bills of lading ordinarily furnished the inspector consists of the following five sheets:

1 original bill of lading (Standard Form No. 1058, white paper).
3 memorandum bills of lading (Standard Form No. 1058a, yellow paper) (one of which is marked "Property Receiving Copy").
1 shipping order bill of lading (Standard Form No. 1059, salmon-colored paper) (unless specific instances require additional copies of the yellow memorandum or salmon shipping order copies).

c. When the car is loaded, the original and all copies of the bill of lading must be completed by inserting on each in the proper place the following information, or so much of it as does not already appear thereon:

(1) Number and kind of packages.
(2) Description of article.
(3) Package or case numbers.
(4) Actual gross weight of the packages composing the shipment.

d. If the shipment is a carload shipment, a car of appropriate size should be ordered and used so as to insure the car will contain the minimum weight required in order to secure the lowest possible freight rate for that particular commodity. On the original and all copies of the bill of lading, note in proper spaces the size of car

ordered, size of car furnished, date furnished, initial and number of car, and the car seal numbers.

e. In order to eliminate excessive charge on making shipments, 36-foot cars should be ordered whenever suitable, as the 36-foot cars are the basis used in quoting rates in connection with Consolidated Freight Classification. If a 36-foot car is ordered and the railroad company should, for its own convenience, furnish a longer one, a 40-foot car for instance, the car furnished should be used for the shipment and a notation made on the bill of lading that a 36-foot car was ordered and a 40-foot car furnished, as in that case charge will be made only for a standard-sized car. But if a 40-foot car is ordered and furnished when a 36-foot car would have served the purpose, it will result in an extra charge by the railroad company. Conversely, if the entire shipment could have been carried in a 40-foot car but not in a 36-foot car, the ordering or use of 36-foot cars (unless for the convenience of the railroad company) would not be justified.

f. In addition to instructions given him by the contracting depot, the inspector should, when he deems it advisable, consult with the carrier's agent or representative at any particular shipping point as to furnishing empty cars, checking, sealing, and pulling of loaded cars when ready, or of loading trap cars.

g. Inspectors should see that shipments are marked in accordance with latest revision of Standard Specification for Marking Shipments, No. 100–2D, attention being invited to section V, paragraph 2 (a) (1), relative marking of shipments which occupy the visible capacity of a car. This would apply also to solid truck loads from factory to a single destination.

101. Completion of Government bills of lading.—When a shipment is ready to be turned over to the railroad company, surrender the shipping order to the agent of the initial carrier indicated thereon, and have him date and sign the original and all memorandum bills of lading where indicated, returning them to inspector. The agent will retain the shipping order. The inspector will mail the original bill of lading and also the memorandum copy, which is stamped "Property Received Copy," to the consignee, each in a separate envelope. Two memorandum copies should be mailed to the contracting depot and one copy given to the contractor (providing a sufficient number of copies are received to allow one for the contractor). In the case the contracting depot is the consignee, that office will, of course, receive the original and "Property Received

Copy," as well as the other two memorandum copies, if they are furnished.

102. Distribution of bills of lading after completion.—*a.* The necessary bills of lading will be supplied by the contracting office for any shipment upon request. It is important that the bills of lading be mailed promptly by the inspector, as outlined above, for the information of the consignee and to avoid delays and demurrage charges.

b. It is sometimes found that the weights shown on bills of lading cannot be verified by the forwarding office after the shipments have been made, in the absence of a weighing certificate made at time shipment is forwarded. In order to avoid occasion for differences in regard to weights between the carriers' agents and the joint rate inspectors and the Government inspectors who fill out the bills of lading, and to eliminate unnecessary correspondence with the settling offices, it is advisable that the following notation, or stamp, be inserted on the reverse side of bills of lading, the date be filled in, and the certificate signed by the U. S. inspector in cases where this method is deemed necessary:

"This shipment weighed, in my presence on _____, Railroad or factory scales and the correct weight noted on the bill of lading. _____ _____" Date U. S. Inspector

c. On technical and preliminary inspections, the inspector will advise the contractor to mail the commercial bill of lading promptly to the consignee to avoid delays and demurrage charges. The commercial bill of lading should not be attached to the invoice, which is mailed to the disbursing officer.

d. The foregoing instructions as to bills of lading and other commercial transportation matters are in general terms only. Care should be exercised in consulting applicable Army Regulations with respect to current detailed instructions.

103. Preparation of contractor's invoices and their distribution.—The inspector is required to see that the contractor mails to the disbursing officer at the address shown in the contract a bill or his invoice, in triplicate, covering the shipment. The bill must cover one shipment only and show package numbers, car number, etc., and is to be certified as follows:

"I certify that the foregoing account is correct and that payment therefor has not been received."

SECTION XVIII

GLOSSARY OF TEXTILE TERMS AND MATERIALS

104. Glossary of textile terms and materials.

Abaca.—A hard fiber from the leaf stems forming the trunk of the abaca plant, incorrectly called "Manila hemp."

Airplane cotton and linen.—Strong linen or mercerized cotton material, with close, even weave, made from combed Egyptian or American Egyptian cotton.

Alpaca.—A smooth, lustrous, wiry fabric originally made with cotton warp and filling of pure alpaca. Now made with cotton warp and filling of mohair, or any lustrous wool. Used for linings and men's summer coats and suits.

Atmosphere, standard.—Air maintained at a relative humidity of 65 percent and at a temperature of 70° F.

Awning cloth.—A heavy canvas, or duck, usually with wide bright stripes, either woven, printed, or painted. Used for awnings, hammocks, etc.

Balbriggan.—Formerly a fine, smooth-knit underwear made from Egyptian cotton. Now applied to certain kinds of unbleached, knitted underwear.

Balloon cloth.—A fine, plain weave, lightweight fabric of silk or cotton.

Bast.—Long cells beneath the woody tissue in the stalk of plants. Linen, jute, and hemp are bast fibers.

Beaver.—A thick, woolen fabric with a napped finish similar to broadcloth. The 30- and 32-ounce fabrics may be compared to kersey. They do not have the hard finish of the melton, and always show a nap. Weave is twill; width, 52 or 60 inches.

Bed ticking.—A strong, closely woven, twilled cotton material usually found in blue or brown and white stripes, yarn dyed. Used for feather beds, mattresses, pillows, etc.

Blanket.—A fabric made of cotton, wool, or mixed fibers. Usually napped. Horse blankets are heavy, felted, and coarse. Weave is plain or twill.

Bleaching.—The process of removing the coloring matter either natural or artificial from textile fibers or fabrics, and leaving them white.

Bleeding.—The staining and dyeing of undyed fabrics or parts of fabrics with colors from other dyed parts or fabrics.

Blending.—A mixture of different kinds of fibers or colors to produce a desired yarn or color.

Bobbinet.—A net made of cotton yarns twisted around each other to produce hexagonal meshes. Used for mosquito bars, curtains, etc.

Book fold.—The fabric is doubled selvage to selvage, then folded back and forth upon itself in predetermined lengths. When the piece is completed, the fold edges on each side are folded once more on themselves so that the fold edges are inside, forming a compact package as long as one-half the width of the goods.

Botany.—(1) Originally fine merino wool from Botany Bay, Australia.

(2) General term for all classes of fine wools.

Broadcloth.—(1) A fine, soft, double width wool material with smooth nap on the face. Better grades very lustrous. Weave is twill.

(2) Fine, closely woven, cotton shirting. Weave is plain.

Broken pick.—A streak across the width of the fabric caused by a completely or partially missing pick.

Bunting.—(1) A cotton fabric made with heavy yarns in a loose texture. Weave is plain.

(2) Wool bunting made of worsted yarns of strong, wiry wool. Used for flags.

Burlap.—A coarse, rough fabric made from jute. Cheaper grades used for bagging. Better grades used for draperies.

Burling.—The removal of knots, burrs, etc., from the surface of the cloth during the finishing process.

Butcher's linen.—A firm, bleached linen fabric made of coarse yarns. Now made of cotton, for utilitarian purposes.

Calendering.—A term used for pressing cloth between heavy rollers during the finishing process, to give it a polish.

Camel's hair.—(1) The hair of the camel.

(2) A soft, napped coating usually tan-colored, originally made from the hair of the camel, but now made of good quality wool and dyed to the desired shade.

Canvas.—A general name for a class of heavy, plain, woven material made of either cotton or linen. Used for tents, sails, awnings, interlinings, tarpaulins. Some canvas is used for art purposes.

Carbonizing.—The removal of vegetable material and fibers from fibers and cloths by treatment with acid or acid-producing chemicals and dry heat. Used on woolen materials.

Carding.—The mechanical operation of untangling and straightening out textile fibers.

Cheesecloth.—Thin, loosely woven cotton material made from coarse yarns. When bleached is used and known as hospital gauze or surgeon's gauze.

Chlorinated wool.—Wool made nonshrinking by treatment with cold solutions of chlorine and hydrochloric acid. Fibers harsh, stiff, and weakened. Increased affinity for dyestuffs. (*See* Unshrinkable wool.)

Circular knit.—A fabric made on a circular, or flat, knitting machine in a tubular form.

Clipping.—Cutting the long fibers on the surface of the cloth to make them equal length. Process used particularly on pile fabrics.

Combing.—A process used in cotton and wool to parallel fibers and separate the short fibers from the long fibers. (*See* Wool, combing).

Corduroy.—A fabric usually of cotton with lengthwise rows or cords of pile on the face. Found in white or any plain color. Much used for suits and trousers for men also for upholstery and hangings.

Cotton felt.—An undyed, cotton material, heavily napped on both sides, used for silence cloths under table cloths.

Cotton gabardine.—A high warp textured cotton fabric of the same weave as wool gabardine.

Count.—(1) *Fabric.*—The number (counted units) of warp yarns (end) and filling yarns (picks) per inch, as 68 by 52, meaning 68 warp ends and 52 picks in the filling.

(2) *Yarn.*—A number given to yarn indicating fineness, based upon the number of yards per pound. More correctly called "yarn number."

Courses (knitted fabric).—A series of adjoining loops from any one yard lying crosswise of the fabric.

Crocking.—The rubbing off of a color from a dyed material to a piece of unbleached cotton fabric.

Cross dyeing.—The dyeing in one bath (or several baths) two different fibers (as wool and cotton) whereby each takes on a different color, or one remains undyed.

Cut.—(1) A unit of yarn number.

(2) The number of 100-yard lengths per pound avoirdupois of asbestos or glass yarn.

(3) The number of 300-yard lengths per pound avoirdupois of *woolen* yard. (*See* Yarn, number.)

(4) The number of needles per inch (in knitting).

Denier.—A unit of yarn number. The number of unit weights of 0.05 gram per 450-meter length. A denier is equal numerically to the number of grams per 9,000 meters. Used in silk and rayons.

Denim.—A firm, strong, twilled cotton material, usually made in dark blue or brown. Used for men's overalls and jumpers.

Direct printing.—The printing or padding of the dyestuffs on the surface of the fabrics.

Discharge printing.—The printing of a pattern with chemicals on the surface of a dyed fabric. When the cloth is submitted to the proper after-treatments, the color is removed at the points where the pattern has touched it.

Dobby.—A loom on which small-figure weaves may be produced.

Doeskin.—(1) A heavy twilled cotton fabric napped on one side. Used for backing on artificial leather and on sport coats.

(2) A woolen fabric with short napped surface.

Doubling.—The process in the manufacture of yarn, in which many slivers are drawn into one. The more the doubling process is performed, the more thoroughly the fibers are mixed and blended.

Down hair.—The soft, fine undergrowth of hair. Certain animals, such as goats and camels, produce both coarse, beard hair and fine, down hair.

Drawing.—The pulling out or attenuating the big, soft rope of fibers (preparatory to the spinning operation) into the desired size of yarn.

Drill or drilling.—A stout, twilled cotton material, bleached, unbleached, or dyed. Many grades and weights. Used for middy blouses, summer trousers, heavy linings, and pockets.

Duck.—A close, heavy cotton fabric; plain weave. Sometimes two yarns used as one in the warp. White or colored. Many widths and weights. Heavy grades practically watertight and used for tents, awnings, sails, tarpaulins, and in the lighter weights for clothing.

Dyeing.—The coloring of material with dyestuffs, from an aqueous solution. (*See* cross dyeing, stock dyeing, and yarn dyeing.)

Ends.—(1) A mill term referring to warp yarns.

(2) Also short pieces of fabrics.

Face of cloth.—The right side as distinguished from the wrong.

Fast color.—A color which is resistant to the action of light, sun, washing, or other special test or chemical.

Feel of cloth.—The sensation produced when the cloth is touched by hand. Expressed as harsh, stiff, firm, or boardy.

Felt.—(1) *Fur.*—A material made from the fur of rabbits, which is blown, matted, and pressed together to form a firm, durable material. Used principally in the manufacture of hats.

(2) *Wool.*—A wool material with the fibers matted and pressed together, obscuring the method of construction. High grade felts

are woven; common felts are not woven. Many weights. Used for billiard tables, pennants, hats, corn plasters, slippers, and rug linings.

Filament.—A variety of fiber (silk or rayon) characterized by indefinite length.

Filling.—(1) Yarn running from selvage to selvage at right angles to the warp in a woven fabric.

(2) Yarn used as filling in weaving.

(3) Used as a collective term for nonfibrous material added to a fabric to increase weight or to fill interstices in coarse or loosely woven cloth.

Fixed.—A term used in dyeing or printing when the colors are made permanent, or fast.

Flannel.—A soft, lightweight wool, cotton, or wool and cotton fabric slightly napped either on face or back, or both. In white, plain, or mixed colors. Used for men's shirts, sport trousers, dresses, underwear, and children's clothes.

Flannelette.—A lightweight cotton material napped on the face. May be white, dyed, or printed.

Flat knit.—A fabric knit on a spring beard needle knitting machine, flat on the back and showing small ribs on the face. It lacks the elasticity of latch needle rib knit fabric. Also called plain knit.

Float.—(1) *Woven fabric.*—The portion of a warp or filling yarn that extends unbound over two or more filling or warp yarns.

(2) *Defect.*—The portion of a warp or filling yarn that extends unbound over yarn with which it should be interlaced.

Flocks.—The short fibers of wool that are clipped from the surface in the finishing process. Used to increase weight of low grade woolens. May be blown in during the fulling operation to make a more solid fabric. Also made by flock grinding machines in shoddy mills.

Fulled or fulling.—A term used to describe a process in the manufacture of wool materials whereby they are reduced in width and length. Other terms for the same process are milled, or felted.

Full-fashioned.—Hose or other garments shaped in the knitting. Selvage joined in seams. Hose requires a second machine to complete the foot. Costs more, but holds its shape and fits better than seamless hose.

Gabardine or gaberdine.—A fine, smooth, wool material woven with a steep twill. Many weights and qualities. Also made in cotton.

Gage or gauge.—(1) *General.*—A generic term for measuring instruments of various types, such as pressure gage, thickness gage, etc.

(2) *Knitted fabrics.*—A measure of fineness expressing the number of needles per unit length (across the wales).

(3) *Hosiery.*—A measure of fineness expressing the number of needles per 1.5 inches *on the needle bar.*

Garnetting.—(1) The tearing of manufactured materials into fibers. One of the first steps in securing wool for remanufacture.

(2) The tearing apart of raw cotton or linters to make a felt (for mattresses).

Gassing.—The singeing or burning off of protruding fibers on cotton yarn, thread, or cloth with a gas flame to make a smooth surface.

Gauze.—*See* Cheesecloth.

Gray goods.—Woven or knitted fabrics which have received no bleaching, dyeing, or finishing treatment. Also known as grey cloth.

Grease wool.—*See* Wool, grease.

Haircloth.—A fabric made with a cotton or linen warp and horsehair filling. Hair filling is thrown to the face by satin weave. Used for millinery and for stiffening in coats.

Handkerchief lawn.—A fabric made of fine, high count, combed cotton in a light weight. Weave is plain. White and in color.

Handkerchief linen.—A fine, soft, linen material used principally for handkerchiefs.

Harness.—Frames holding the heddles which raise and lower the warp threads during weaving.

Heddle.—A device through which warp yarns pass to facilitate weaving.

Herringbone twill.—Zigzag effect produced by alternating the direction of the twill. Resembles the backbone of a herring.

Homespun.—A coarse, strong wool material made of rough, woolen yarns in mixed colors. Similar to tweed. Used for overcoats and suits.

Huck or huckaback.—A fabric made of cotton, linen, or combination of these with a small, figured design. Used for towels.

Humidity, relative.—The ratio of actual density (or pressure) or existing water vapor to maximum possible density (or pressure) of water vapor in the atmosphere at the same temperature, expressed as a percentage.

In the grease.—Wool as it leaves the sheep's back before scouring.

In the gray (or grey).—Unbleached, or undyed, cotton or linen cloth.

In the gum.—Silk in its raw or natural state before degumming. It contains sericin (silk gum) which makes it stiff and dull.

Jersey.—A general term given to plain-knitted material used for garments. May be of cotton, wool, silk, rayon, or a mixture of fibers. Great variety of weights, qualities, and colors. Used for underwear, blouses, gowns, suits, coats, etc.

Kemp.—The coarse, dead or diseased wool fibers in fleece. They do not dye.

Kersey.—A thick, woolen cloth similar in construction to melton, but finished with a short thick nap. May contain cotton warp with wool filling, or have cotton mixed with wool in yarn. Much like a heavy broadcloth. Used for uniforms and overcoats. Weave is twill or double plain.

Khaki.—A strong, twilled cotton material of tan color used for uniforms. Many weights and qualities. Also used for summer suits and outdoor work clothes.

Knit.—Not woven with warp and filling, but produced by a series of loops of yarns.

Lace.—Materials of open structure, made either by hand or on lace machines.

Lap.—A wide sheet of fibers before it is drawn out into slivers.

Latch needle.—A needle having a pivoted latch for entry and removal of yarn, used in ribbed knitting on flat or circular latch needle knitting machines.

Lawn.—A lightweight, fine count, carded or combed cotton fabric.

Lea.—(1) A unit of yarn length.

(2) A 300-yard hank of linen yarn.

(3) A skein used for strength tests. The skein contains 80 turns, each of 1.5 yards in length.

Lease eye.—The eye in the center of the heddle, through which the warp yarn is drawn.

Linen.—Yarn, thread, or fabric made from flax fibers.

Linene or linon.—A cotton fabric finished to imitate linen. Finish destroyed in laundering.

Lint.—Cotton fiber after ginning.

Linters.—Short cotton fibers obtained from the cottonseed after ginning. Used for upholstery stuffing or as raw material in rayon manufacture or guncotton.

Lisle.—A fine, smooth, cotton yarn, 2-ply, for knitting purposes. Made from long staple cotton, tightly twisted and gassed.

Load, breaking.—For a specimen of any material, the maximum load developed in a tension test carried to rupture. The breaking load is read directly from the testing instrument.

Loops (raw silk).—Small, open places in the yarn, due to the excessive length of one or more cocoon filaments.

Loop-knot.—A snarl, or curl, produced by a filling yarn coiling upon itself.

Mackinaw.—Heavy wool coating, usually of durable cloth, yarn dyed and woven in plaids. May have cotton warp or cotton mixed in yarns. Used for coats for men, women, and children.

Manila hemp.—*See* Abaca.

Melton.—A thick, smooth, woolen fabric, usually heavier than broadcloth or kersey. May contain cotton warp and woolen filling. Felted, napped, shorn close, and given a dull finish.

Mercerizing.—A treatment of cotton yarn, thread, or fabric with a strong solution of sodium hydroxide under tension. The treatment renders cotton permanently more lustrous and stronger, and gives it a greater affinity for dyestuffs.

Merino.—(1) Name of a breed of sheep.

(2) A yarn made of a mixture of cotton and wool.

Mill waste.—A general term for the byproducts of various mill operations.

Mohair.—(1) The hair of the Angora goat.

(2) Fabric practically the same as brilliantine; also called Alpaca.

(3) Pile fabric with back of cotton wool and pile of mohair; cut and uncut loops.

Moisture.—The moisture present in a textile material as determined by definite prescribed methods, expressed as a percentage of the original weight.

Moisture regain.—(1) *General.*—The moisture present in a textile material as determined by definite prescribed methods, expressed as a percentage of the oven-dry weight.

(2) *Commercial.*—An arbitrary figure formally adopted as the regain used in calculating the commercial or legal weight of shipments or deliveries of any specific textile material.

(3) *Standard (individual samples).*—The moisture regain of a sample of textile material when brought from a lower moisture regain into equilibrium with the standard atmosphere. The lower moisture regain may be that reached at equilibrium in any atmosphere having a relative humidity between 5 and 50 percent.

Moleskin.—A fabric having a thick, soft nap pile back usually twill face, like fur of a mole. Made of cotton and used as a foundation for some artificial leather.

Mordant.—A metallic hydroxide, or oxide, which is deposited on the fiber from a solution of its salts and which is capable of forming an insoluble colored compound with the dyestuff.

Mungo.—The lowest class of remanufactured wool reclaimed from felted woolen fabrics.

Muslin.—A firm, plain, cotton fabric, either white or unbleached. Heavy and wide muslin is called sheeting. Used for underwear and household purposes.

Nainsook.—A fine, smooth, soft cotton fabric, usually white, but may be tinted. Many grades.

Napping.—Pulling the ends of fibers to the surface of the cloth, to form a fuzz or pile. When done with teazel burrs the process is called teazeling. Outing flannel is an example of napped goods.

Net or netting.—An open work material usually made on the lace machine.

Noils.—Short fibers from the combing of wool used to make worsted yarns. There are also silk noils and ramie noils.

O. D.—An abbreviation for "olive drab," which is the shade of some Army fabrics.

Oiled silk.—Thin silk, soaked in drying oils or resins, and dried. Waterproof and fairly pliable.

Organzine.—*See* Yarn silk.

Osnaburg.—A strong, unbleached cotton bagging, similar to heavy muslin. Kind of crash. Used for cement bags and sacks and target cloth. Also substitute for burlap.

Parachute silk.—A strong silk manufactured especially for aircraft use.

Paraffin duck.—Canvas or duck treated with paraffin. Stiff, heavy, and waterproof.

Percale.—A smooth, closely woven cotton material, usually printed. Has replaced high-grade calico or print.

Perch.—A machine used in the examination of cloth.

Perching.—The inspection of cloth during or after manufacture.

Pick.—A strand of single or plied yarn the width of the woven cloth.

Pick glass.—A small magnifying glass used to count the number of yarns in warp and filling.

Piece dyed.—Cloth dyed after weaving.

Pile.—The raised loops or tufts (cut loops) that form all or part of the surface of a pile fabric. Also known as pile fabrics.

Pima cotton.—Cotton grown in southern California and Arizona from Egyptian seed. Long staple fiber, light tan in color.

Pitch (pile floor covering).—The average number of pile ends per inch counted in the filling-wise direction.

Plain weave.—The simplest of the fundamental weaves. Each filling yarn passes alternately under and over each warp yarn.

Plush.—A fabric having a strong, straight pile on one side. Made of silk, wool, cotton, rayon, or a mixture.

Ply.—(1) The number of single yarns twisted together to form a ply yarn.

(2) The numbed of ply yarns twisted together to form a cord.

(3) The individual yarn in a ply yarn or cord.

(4) One of a layer of fabrics.

Poplin.—A fine corded fabric, made with fine warp and coarse filling. May be made of cotton. Many grades. Used for shirts, suits, dresses, trimmings, and hangings.

Powder silk.—A spun silk fabric made for holding the explosive charge for big guns.

Press cloth.—A strong material made of cotton, linen, glass, or other inert synthetic fiber and used for filtering.

Pressure, water vapor.—The component of atmospheric pressure caused by the pressure of water vapor. Water vapor pressure is expressed in inches or millimeters of mercury.

Print.—A general term for printed cotton fabrics.

Pulled wool.—*See* Wool, pulled

Raw material.—Textile fibers which are used in any manufacturing process.

Rayon.—(1) *General.*—A generic term for filaments made from various solutions of modified cellulose by pressing or drawing the cellulose solution through an orifice and solidifying it in the form of a filament. Rayon is manufactured in two forms—continuos filament yarn and staple fibers of spinnable length.

(2) *Acetate rayon or cellulose acetate.*—This is a filament or staple made from an acetic ester of cellulose.

(3) *Cuprammonium rayon.*—Made from a regenerated cellulose which has been coagulated from a solution of cellulose in ammoniacal copper oxide.

(4) *Nitro or nitrocellulose rayon.*—Made from a regenerated (denitrated) cellulose which has been coagulated from a solution of nitrated cellulose.

(5) *Viscose rayon.*—Made from a regenerated cellulose which has been coagulated from a solution of cellulose xanthate.

Rayon staple.—Rayon fibers of spinnable length, manufactured directly or by cutting continuous filaments.

NOTE.—Rayon staple does not include cut rayon waste.

Reclaimed wool.—Wool fiber taken or reclaimed from manufactured materials. Commonly called "shoddy".

Reed marks.—Marks or lines warpwise in the cloth, usually caused by too many or too few warp yarns being drawn into a dent, a faulty setting of the loom, or imperfections in the reed.

Rib knit.—A knit fabric with lengthwise ribs, or wales alternating on the right and wrong sides. This is called a 1 by 1 rib knit. There are other combinations, as 2 by 2, or 3 by 1, etc.

Roving.—A loose assemblage of fibers, drawn into a single strand, with little twist. An intermediate step between sliver and yarn.

Sailcloth.—*See* Duck.

Sateen.—A smooth, high-lustered, cotton fabric in satin weave. White, dyed, or printed.

Satin.—A smooth, silk fabric made of a basic weave called "satin weave."

Schreinerizing.—A kind of calendering which produces a high luster on cotton cloth. Lustrous effect is not permanent.

Seconds.—Materials containing imperfections of such nature as to affect the suitability or quality of the material.

Selvage.—The woven edge portion of a fabric parallel to the warp. It has, usually, an increased number of ends per inch.

Serge.—A firm, strong, wool material made with a standard 2-up-2-down twill weave. May be coarse, harsh, and wiry, or fine and soft as high-grade dress serge. Many grades and weights.

Shedding.—A term used in weaving to describe the opening in the warp yarns for one passage of the shuttle.

Sheeting.—A firm, plain-woven cotton (or linen) material. Varies in width from 36 to 108 inches. (*See* Muslin.)

Shoddy.—A broad term for all reclaimed wool.

Silesia.—A closely woven, lightweight, smoothly finished, cotton fabric. Used for linings, trouser pockets, etc.

Silk.—(1) *Boiled-off.*—Silk with the sericin (gum) removed.

(2) *Raw.*—Silk as it is reeled from the cocoon.

(3) *Thrown.*—Raw silk that has been degummed, twisted, doubled, and twisted as organzine, tram, crepe fabrics (high twist), embroidery (heavy twists), etc.

Singeing.—*See* Gassing.

Sizing.—A generic term for compounds which, when applied to yarn or fabric, form a coating around the yarn or fabric to stiffen it, strengthen it, or give it a special handle.

Skein.—A coil of yarn or cord obtained by winding.

Skirting.—The removal of the tag ends and torn edges from a fleece of wool.

Sliver.—A thick, soft rope of parallel fibers which is drawn and twisted to form a yarn.

Slubbing.—A stage of manufacture of yarn before it is drawn into roving.

Slub or slug.—An abruptly thickened place in the yarn, or a bunch of lint entangled in the yarn, cord, or fabric.

Smash.—A place in the fabric where a number of warp or filling yarns have been broken during weaving.

Spinning.—A process of drawing and twisting fibers together to produce an end of yarn.

Splicing.—Hose reenforced by a different kind of yarn in heel and toe to add strength. It is usually cotton.

Sponging.—Process of shrinking fabrics before cutting into garments by wetting the cloth, squeezing out the surplus water, and drying.

Spring needle.—A needle used in flat or plain knitting. Yarn is forced into the loop of the needle by the "spring" or tension of the metal. (*See* Latch needle.)

Spun rayon.—*See* Yarn, spun rayon.

Stock dyeing.—Dyeing of fibers in the loose form (not yarn).

Strength.—A generic term for that property of a material by virtue of which it can resist strain or rupture induced by external forces.

Strength.—(1) *Breaking.*

(*a*) *General.*—The ability of a material to resist rupture by tension.

(*b*) *Specific.*—The breaking load when tested under specified conditions.

(2) *Bursting.*—The ability of a material to resist rupture by pressure.

(3) *Tearing.*—The ability of a material to resist division.

(4) *Tensile.*—The breaking strength of a material expressed in force per unit cross-sectional area of the original specimen or its equivalent.

Suiting.—A general term applied to a variety of weaves, weights, and finishes. Weaves are plain, fancy, or twill.

Tag locks.—The dirty, stained portions around the edges of a fleece.

Tape.—A narrow, woven fabric. Regarded by some as not over 8 inches in width.

Tender.—A mill expression, meaning to weaken when used in connection with the injurious effect of chemicals on a fabric.

Tentering.—A machine which grips the fabric at the selvages and pulls it to the desired width.

Terry cloth.—A cotton or linen (rare) fabric with a looped pile on both sides. Heavier weights called turkish toweling and used for towels, bathrobes, slippers, and draperies.

Thread, sewing.—A variety of yarn, normally plied, characterized by a combination of twisting and finishing with solid or semisolid, waxlike materials to secure a smooth, compact strand which is quite flexible and presents no loose fibers.

Ticking.—A strong twilled cotton fabric with yarn dyed lengthwise in stripes of blue, red, brown, etc. with white. Used for pillows and mattresses.

Top.—The large, soft balls of combed wool fiber.

Topping.—A tinting of a dyed fabric by running it into a bath of a different color.

Tricot.—(1) An old name for jersey cloth.

(2) A form of warp knitting.

Tube.—(1) A holder or bobbin of cylindrical shape used as a core for a yarn package of cylindrical form.

(2) A cylindrical yarn package formed by winding on a tube.

Turkish toweling.—*See* Terry cloth.

Tweed.—A rough, coarse cloth made from woolen spun yarns, containing wiry and heavy wools. Stock or yarn dyed. Very durable. Used for coats and suitings. Weave is usually plain.

Twill.—A fundamental weave with many variations. Found in denims, serges, and Canton flannel.

Twist.—(1) *General.*—The turns about its axis, per unit of length, observed in a fiber, yarn, or cord. Twist is expressed in turns per inch or per meter.

(2) *Balanced.*—An arrangement of twist in a ply yarn or cord which will not cause twisting on itself when the yarn or cord is held in form of an open loop.

(3) *Cable.*—A twist, cord, or rope construction in which each successive twist is in the opposite direction of the preceding twist, as *S/Z/S* or *Z/S/Z* construction.

(4) *Direction.*—A yarn or cord has *S* twist if, when held in a vertical position, the spirals conform in direction of slope of the central portion of the letter "S", and *Z* twist if the spirals conform in direction of slope to the central portion of the letter "Z".

Two-ply.—A yarn or thread in which two strands or singles are twisted together.

Unfinished worsteds.—Worsted fabrics that have a nap developed on the surface which is given a very light shearing so that the pattern is obscured. The term is a misnomer, as the process is a finish on worsteds.

Union fabrics.—A fabric made of different yarns and fibers, as a cotton filling, linen warp, or cotton warp, wool filling.

Unshrinkable wool.—Wool which has been treated with chlorine or chlorine-producing compounds, which reduce the amount of shrinkage in laundering. In spite of the treatment the woolen fabric continues to shrink to some extent. (*See* Chlorinated wool.)

Upland cotton.—General classification of all cotton grown in the highlands of the South. Short staple; distinguished from Pima, sea-island, or Egyptian cotton.

Virgin wool.—Wool that has not been used in the previous manufacture of yarn or fabrics.

Wale (*knitted fabrics*).—A series of loops in successive courses, lying lengthwise of the fabric, and formed by the action of one needle.

Warp.—(1) The yarn running lengthwise in a woven fabric.

(2) The sheet of yarns laid together on a beam to form a warp.

Warp-knit fabrics.—A fabric knitted on a special knitting machine which produces a flatter, closer, and less elastic material than produced by other machines.

Webbing.—A strong, closely woven, narrow, cotton material, for belts and straps. Also made in silk, linen, or mixtures.

Weight.—(1) *Commercial.*—The oven-dry (bone-dry) weight of a textile material plus the weight corresponding to its commercial moisture regain.

(2) *Oven-dry.*—Also known as "bone-dry" weight. The weight of a textile material determined after drying by definite prescribed methods.

Whipcord.—A firm, smooth material of wool, cotton, or a mixture, with a conspicuous diagonal cord across the face.

Wool.—(1) *Combing.*—Wool that is strong and strictly of combing length, that is, 2 or more inches in length.

(2) *Grease.*—Wool as it comes from the living sheep, not washed or scoured.

(3) *Pulled.*—Wool taken from the skin of a slaughtered sheep's pelt by slipping, sweating, or with a depilatory.

(4) *Top.*—A continuous, untwisted strand of wool fibers, from which the shorter fibers or noils have been removed by combing.

Woolens.—A general term for soft wool materials. Spun on woolen system.

Worsteds.—A general term for firm, smooth, wool materials, made of combed wool yarns.

Wrong draw.—A defect in a fabric due to the fact that the warp and filling do not interlace in accordance with the prescribed weave or design and caused when one or more warp yarns have been drawn through the wrong harness.

Yarn—(1) *General.*—A general term for an assemblage of fibers or filaments, either natural or manufactured, twisted or laid together to form a continuous strand suitable for use in weaving, knitting, or otherwise intertwining into textile materials.

(2) *Construction.*—A term used to indicate the size of a single yarn and the number of strands combined to form each successive unit of a ply yarn or cord.

(3) *Dyeing.*—The dyeing of a textile material in the form of a yarn.

(4) *Number.*—A conventional system of fineness measure. (See sec. IV.)

(5) *Spun rayon.*—Yarn spun from rayon staple cr cut from rayon waste.

(6) *Woolen.*—Yarn spun from wool fibers which have been carded but not combed or gilled.

(7) *Worsted.*—Yarn spun from wool fibers which have been carded and either gilled or combed, or both. (*See also* Wool, combing.)

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